1.0 Introduction/Executive Summary
2.0 Site Description
3.0 Project Description
4.0 Alternatives
5.0 Costs
6.0 Environmental Effects & Control Plans (to 6.6)

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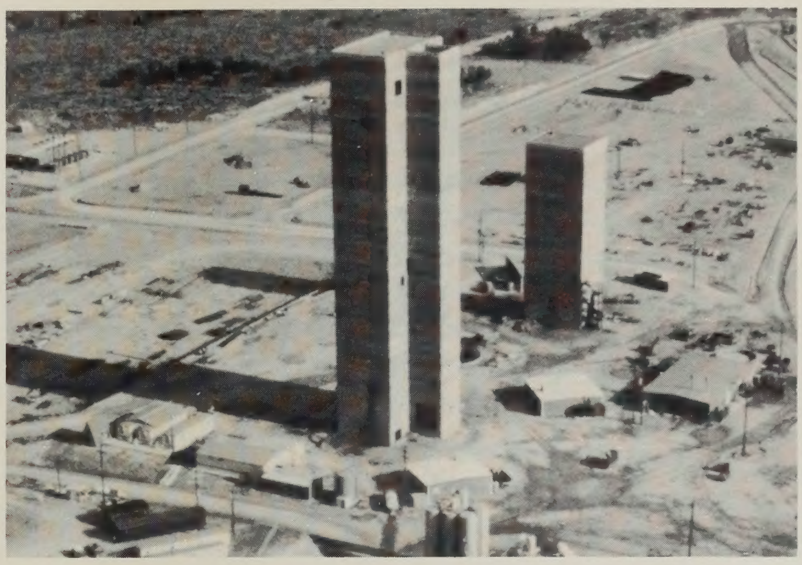

Revised Detailed Development Plan

1984

Cathedral Bluffs Shale Oil Company

A Colorado Partnership of Occidental Oil Shale, Inc. and Tenneco Shale Oil Company

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Mine Water Treatment Facilities are described in Section 3.8.3.

3.3.8 Mine Ventilation

Room and pillar mining and MIS void mining are development-intensive mining methods, which place high demands on the ventilation system. Each separate working place must be ventilated to prevent buildup of dust, detonation products, methane gases, and diesel exhaust fumes.

3.3.8.1 General

Control of the ventilation system of a moderately deep oil shale mine is straight forward due to the considerable knowledge available on ventilating room and pillar mining operations. The major elements of the ventilation system will be: main exhaust fans which supply the necessary energy to overcome flow resistance; stoppings, doors and overcasts to separate intake airways from return airways; regulators to control the volume (by controlling the resistance) of parallel branches; and auxiliary fans and ducting to carry air to dead-end working areas.

A conceptual diagram of the Room and Pillar mine ventiliation system is shown on Figure 3.3-9 and the MIS ventilation system is shown on Figure 3.3-10.

The quantity of air entering and leaving the mine will be controlled by adjusting the main fans. The quantity of air required for the mine is directly related to underground production and operating diesel horsepower.

The paths air takes through the mine will be controlled by stoppings, doors, and overcasts. Stoppings and doors are constructed in entries or crosscuts to separate intake from return air in a multi-entry system or to seal off old workings. Overcasts or undercasts are installed to allow intake and return

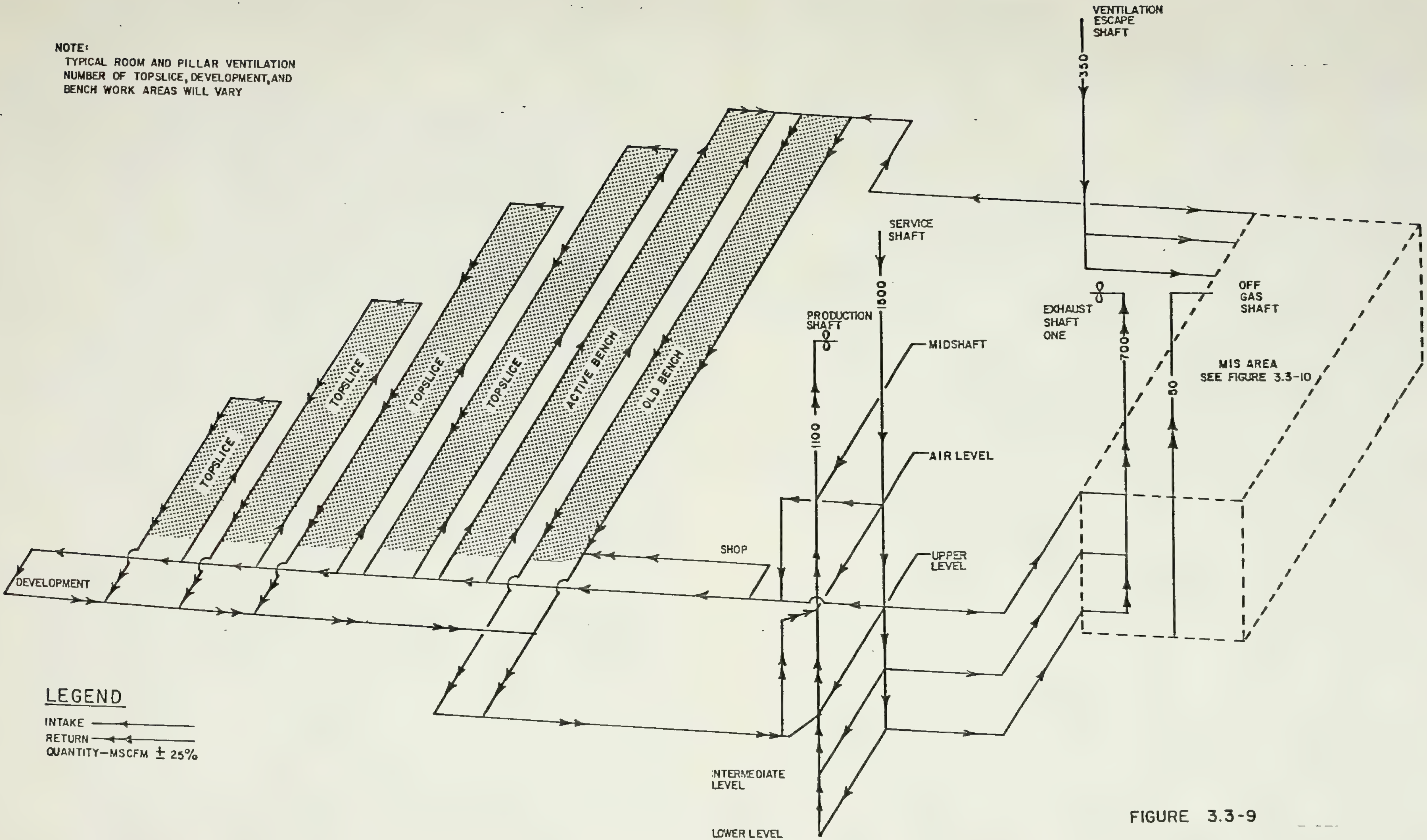
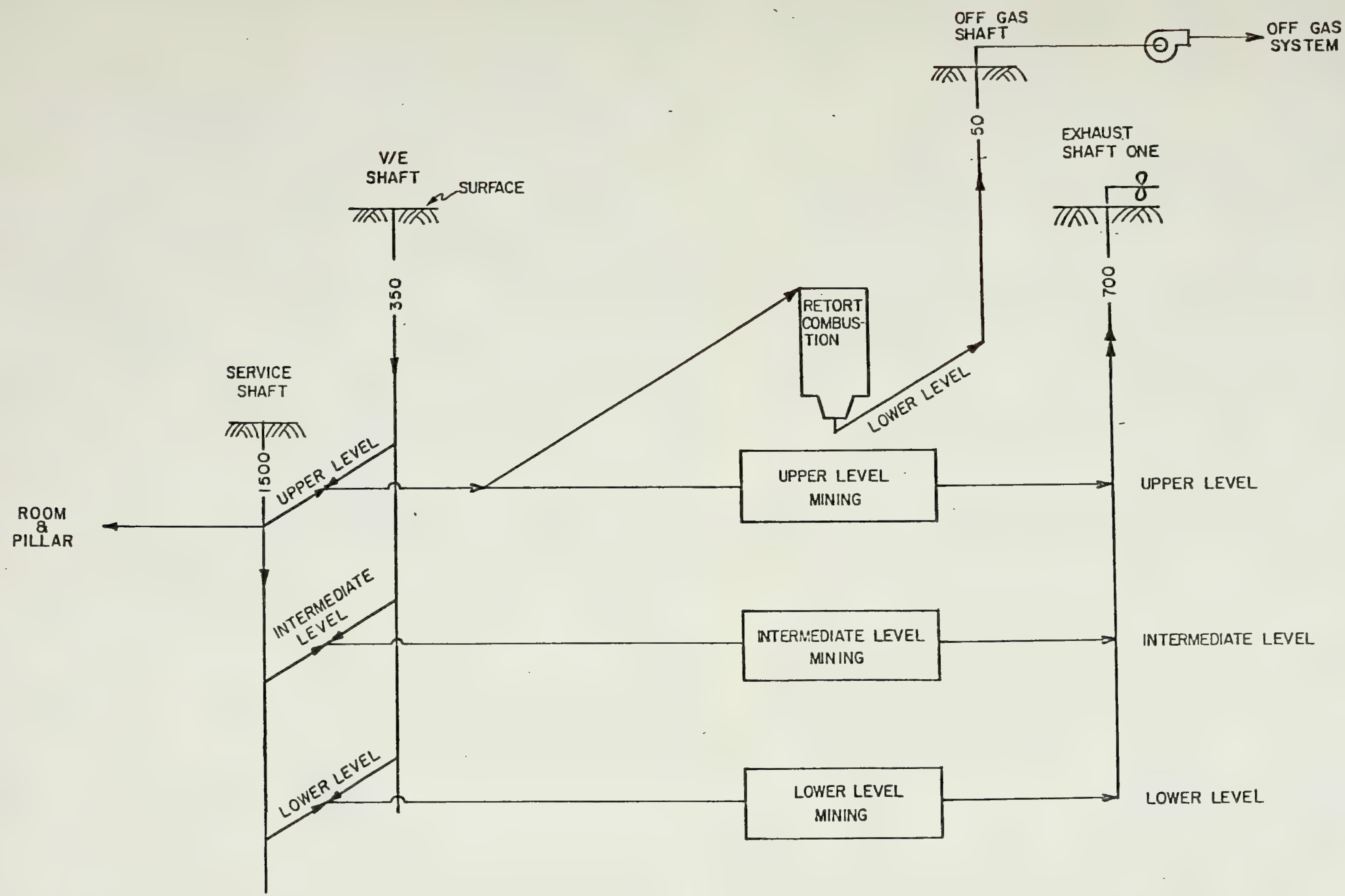


FIGURE 3.3-9

CONCEPTUAL DIAGRAM OF THE ROOM
AND PILLAR MINE VENTILATION SYSTEM



QUANTITIES IN MSCFM ± 25%

FIGURE 3.3-10

CONCEPTUAL DIAGRAM OF THE MIS VENTILATION SYSTEM

airways to cross paths. These structures, stoppings, doors, and overcasts will predominantly be prefabricated steel structures to minimize labor installation cost. Leakage will be controlled through the use of sealants.

The quantity of air entering a production panel is controlled by pressure regulation. Regulators, i.e., stoppings with adjustable openings, will be used for quantity control into or out of each production panel.

Regular surveys by ventilation engineers will be conducted to balance the system and inspect for problems (e.g., leakage, air quality, degredation and unauthorized distribution changes). The underground ventilation system must be designed to be flexible because the mine geometry will always be changing.

Design concepts for the development of the planned system are as follows:

- MIS and Room and Pillar operations are to be on separate splits of air with separate exhaust shafts.
- Existing equipment and shafts will be utilized to the fullest extent possible.
- The ventilation system will be based on MSHA gassy mine requirements and will meet or exceed MSHA ventilation/air quality standards.
- Ventilation quantity buildup will be in accordance with the mine development schedule.

The mine ventilation system will be a negative-pressure system with the main exhaust fans located on the surface.

3.3.8.2 System Stages

The ventilation system will be expanded in stages as mine development progresses. The Production Shaft is presently the only exhaust shaft. The Service Shaft serves as the intake shaft. This system will ventilate both the Room and Pillar and MIS development up to the ignition of the first retort.

The start of MIS retorting will require completion of Exhaust Shaft 1 (ES1). This shaft is located on the northern part of the plant pillar as shown on Figure 3.3-2. Intake for the MIS area will be provided by the V/E Shaft and partially by the Service Shaft.

3.3.8.3 Quantities

Four factors were considered in determining ventilation requirements:

1) Velocity - A minimum velocity must be maintained to promote mixing of air in the large rooms.

2) Diesel hp - A minimum allowance of 125 CFM per diesel horsepower must be provided.

3) Methane dilution - Sufficient air must be provided to maintain an average methane concentration of less than 1% in all parts of the mine, including return airways.

4) Leakage - Approximately 15% of the intake air does not reach the work places, but leaks directly into the return air system.

The minimum velocity criterion is the controlling design factor in the large rooms, whereas diesel horsepower controls the amount of air required in drift and top slice headings. Additional air requirements include ventilation for mine shops and sumps. Mine ventilation requirements depend heavily on development schedule and buildup.

3.3.8.4 Distribution

Some important features of the air distribution systems are as follows:

1) System segregation - The MIS area is operated at a lower pressure than the Room and Pillar area and both systems have their own exhaust shafts. In the event of an upset, either system can be isolated.

2) Air level - Most of the intake air will be taken from the Air Level and coursed down a raise to the high speed ventilation drifts on the Upper Level.

3) High speed intakes - High speed drift intakes will be used to distribute air to the Room and Pillar work areas. These drifts will not be used for access.

4) Old workings as returns - Abandoned panels will be used as a return air system whenever possible. This allows a single drift to be used for return air in the submains which support all drift and top slice development.

3.3.8.5 Room and Pillar Work Areas

There are three types of mining work areas: (1) development, the extension of submains; (2) top slice or first development in the panels; and (3) benching involving removal of the floor from the panel. Ventilation of the development section and top slice sections is very similar; therefore, only the top slice section ventilation plan is discussed.

Distribution at the face area in the top slice section will be by vent bag and auxilary fans blowing air to the working face. Air coming from the working

face will be diluted by clean air at the last open crosscut. This type of face ventilation is common to trona, potash, and other room and pillar mining operations.

The primary ventilation circuit for the top slice section is as follows: air will be received from the high speed intake and proceed down the right side of the panel, across the last open cross cut, and return up the left side, through an overcast, and out the submain return (belt) entry. Intakes and returns will be separated by stoppings. These stoppings will be prefabricated steel panels. This style stopping was chosen as it is reusable and quickly installed. The last stopping will be a temporary brattice curtain. A rigid stopping is not used in this area because of potential damage due to blasting.

Ventilation of the bench area will be relatively simple because the ventilation circuit is already established. Air from the high speed ventilation drifts flows in the front of the bench panel and exits out the rear. Curtains and/or air movers (small fans) will be used on an "as needed basis" to direct air or balance flow in the benching sections.

3.3.8.6 MIS Work Areas

The supply air for the MIS section will come from the Ventilation/Escape (V/E) Shaft and from the Service Shaft and be exhausted through the MIS Exhaust Shaft. During early stages of development of the MIS panel, both supply and return air will be via the Production and Service Shafts until the connection is made with the V/E Shaft and the new Exhaust Shaft is completed.

The ventilation criteria are consistent with those used for the room and pillar operation, and meet or exceed all mandatory MSHA requirements.

The major elements of the ventilation system will be the main exhaust fans, which provide the necessary energy to overcome flow resistances; stoppings, and doors to separate intake airways from return airways; regulators to control air flow rates (by controlling the resistance) in parallel branches; and auxiliary fans and tubing (ducts) to carry air to dead-end working areas.

The quantity of air entering and leaving the MIS section will be controlled by exhaust shaft main fans and is estimated at one million actual cubic feet per minute (ACFM).

The quantity of air flowing through each level and the various cluster drifts will be controlled by pressure regulation. The underground ventilation system will have the flexibility to accommodate future changes in mine geometry.

In addition to providing adequate ventilation for the mining activities in the MIS section, combustion air will be provided for the retorts. All of the MIS combustion air will come from the Upper Void Level. Air flow to each retort will be induced by negative internal pressure (relative to the interior of the mine and ambient). Retort offgas compressors will provide negative pressure in the retorts and will be connected to the retorts at the Product Level. In this manner, the combustion air, after entering the retort, will remain segregated from the mine air. The regulation of the air flow into the retorts will be by dampers controlled by flow sensors. The dampers will automatically close if there is a loss of the negative pressure in the retort.

Regular surveys by ventilation engineers will be carried out to balance the system and inspect for problems.

3.3.8.7 Environmental Control

Temperatures in the mine will be regulated to a maximum of 86°F through the use of evaporative cooling if the mine atmosphere does not moderate the air temperature through its natural water sources. Without some cooling, mine air in

the dry state can rise to over 100°F due to the use of diesel and electrical equipment. Two mechanisms will moderate temperatures: evaporation of natural water into mine air, especially in the shaft area, and conduction of heat into the cold (75°F) rock walls.

During the winter, intake mine air will be heated to 35°F in order to eliminate problems of ice buildup in the shafts. This will be accomplished by using direct-fired natural gas heaters at the intake shaft collars.

Fresh ventilation air will be coursed through the mine shops and routed directly to a major return drift to ensure that fumes from the shops and electrical substation do not affect the fresh air provided to the working areas.

3.3.9 Surface Support Facilities

The mine surface facilities are shown on Figure 3.2-4 along with the existing mine shaft locations. A photograph (Figure 1.1-1) of the temporary mine support facilities showing the Production and Service Shaft headframes provides an overall perspective of the facilities as they existed in 1982. The surface facilities that support the mining operations are summarized in Section 3.8.15.

3.3.10 Mine Utilities

Mine utilities except for communications and monitoring are addressed in Section 3.8.

3.3.10.1 Mine Communications and Monitoring

3.3.10.1.1 Communications

General communication within the mine and between the mine and surface will be provided by a multi-channel dial/page phone system. Each phone station will

be capable of contacting any other phone station within the network whether underground or on the surface, and will also be capable of selectively paging any other station. A multi-tone signal generator will be included to allow for announcing blasting, all clear, evacuate, and other warning signals. Interface with the public telephone system will be provided through a switchboard panel on the surface.

Power failures will not affect the system. Each station will be equipped with a 12 volt battery for temporary emergency power. The entire underground system will be linked to the surface with a multi-pair communication trunk similar to the one used for mine monitoring.

Design of the communication system will accommodate the need for continued serviceability in the event of a mine disaster or fire. "Hardening" and redundancy will be incorporated to maintain the integrity of the communications during an emergency. Control features will allow the system to be prioritized for handling emergency communications.

3.3.10.1.2 Mine Monitoring System

The mine environment and the critical mine operations functions will be automatically monitored using electronic sensors tied into a mine monitoring computer located on the surface.

A separate process monitoring and control system will be installed for the MIS retort operations. This system is described in Section 3.6.3.

3.0 PROJECT DESCRIPTION

3.4 Materials Handling

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3.0 PROJECT DESCRIPTION

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3.0 PROJECT DESCRIPTION

3.4 Materials Handling

3.4.1 Introduction/Summary

Oil shale will be mined and crushed to a nominal 8 inch lump size underground before being hoisted to the surface and discharged to the Production Headframe storage bin. A block flow diagram of the materials handling scheme is presented on Figure 3.4-1. The surface Materials Handling Facilities are grouped into two major areas: Raw Shale Preparation and Processed Shale Disposal. Raw Shale Preparation includes crushing the shale to less than 2-inch size and screening the retort feed to remove fines at less than 1/8 inch size. Provisions are included for maintaining a 12 day inventory of mine production. Spent shale disposal involves transportation of the spent shale, discarded raw shale fines, and FGD sludge from the MIS Flue Gas Desulfurization Unit to an allocated area and disposal in accordance with a reclamation plan that will be approved by the Mined Land Reclamation Board prior to plant start-up.

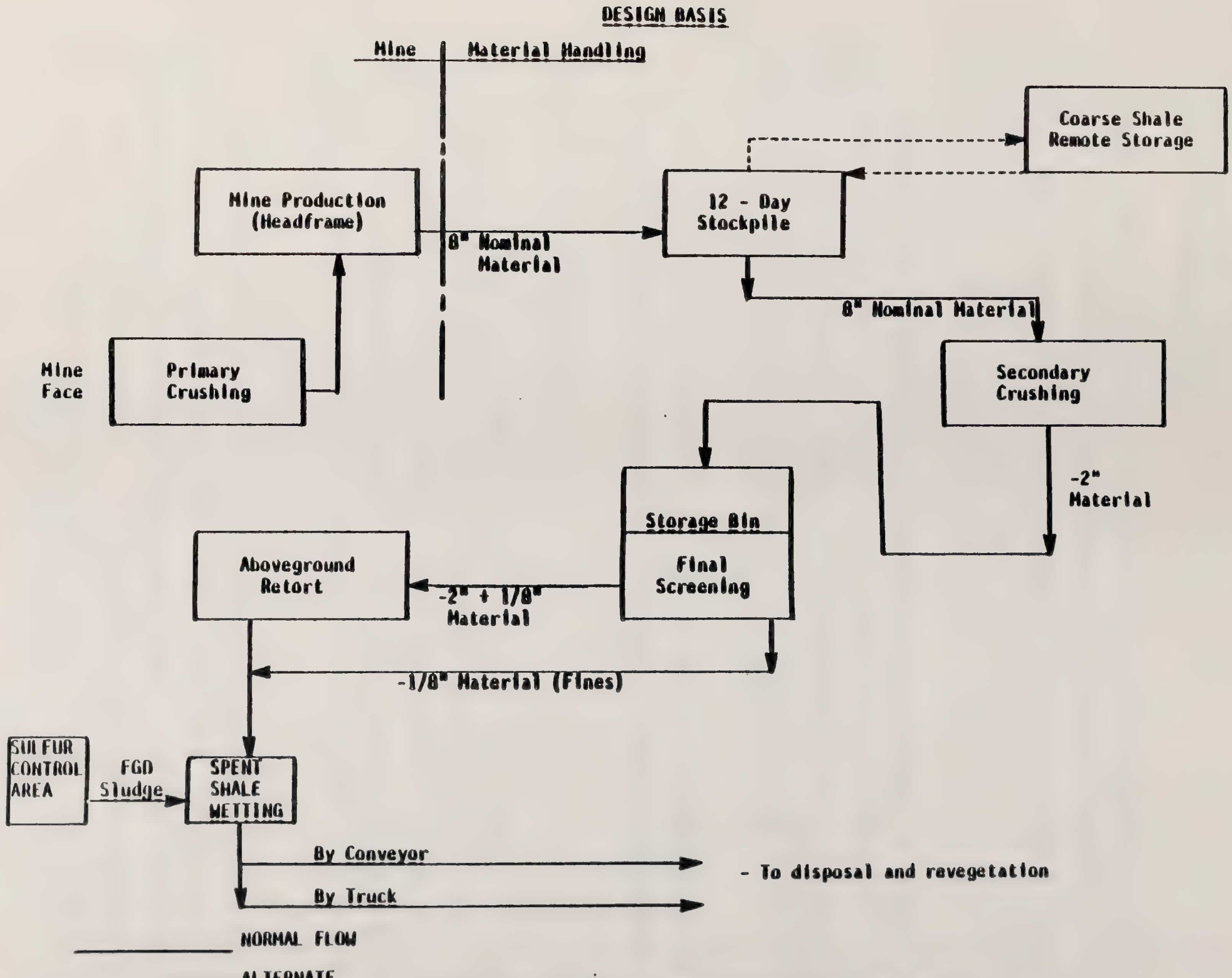
3.4.2 Schedule

Construction of the initial Materials Handling Facilities will begin in 1984. These facilities will consist of a conveyor and a truck load-out area to handle the initial mine development rock. The remainder of the Materials Handling Facilities and the Spent Shale Handling Facilities will be constructed in 1985 to 1986 and will be operational prior to aboveground retort start-up in late 1987.

3.4.3 Raw Shale Handling

3.4.3.1 Process Description

Oil shale will be mined and crushed to a nominal 8 inch lump size before being hoisted to the surface and discharged into the Production Headframe storage bin. The shale will be drawn from the bin with an apron feeder and conveyor which will feed a 150 ft. high lowering well to build a 12 day stockpile.



BLOCK FLOW DIAGRAM - Materials Handling (Surface)

FIGURE 3.4-1

3.4 Materials Handling

Apron feeders will reclaim the stockpiled shale at four draw points and will feed a single tunnel conveyor. This conveyor will elevate the shale to a belt conveyor feeding a scalping screen that removes material less than 2 inches in diameter from the crusher feed. Screen oversized material will be directed to the crusher which reduces the shale to less than 2 inches.

Crusher discharge combined with screen undersized material will be transported to the Fine Ore Surge Bin. The shale will be discharged from the Fine Ore Surge Bin by means of three variable speed belt feeders. They will feed the finishing screens which deliver the material sized greater than 1/8 inch to a single conveyor which in turn feeds the aboveground retort (AGR).

The minus 1/8 inch material will be transferred to the processed shale wetting area where it will be combined with processed shale and FGD sludge.

3.4.3.2 Environmental Control

In general, the surface Materials Handling Facility is subject to the same environmental regulations as any above ground bulk materials preparation and handling facility in a new oil processing or mining operation located in Colorado. The primary area of concern is air quality. Best available control technology (BACT) is required and is discussed in the Air Quality Control Plan (Section 6.2).

The air quality regulations pertain to emissions of fugitive dust which will be from four main sources: crushing, screening, stockpiles, and general transporting of shale. Exposure to the elements only occurs at the stockpile. In all other areas dust enclosures will be provided and insertable baghouses will be strategically placed to handle major emissions from crushing, screening and conveyor transfer points. Fugitive dust generated by truck haulage and

emissions from raw shale stockpiles will be controlled with water sprays or dust palliatives. Roads will be paved and good housekeeping practices instituted to minimize normal fugitive dust emissions.

3.4.3.3 Process Selection

CB was assisted by Stearns-Roger, Denver, in the selection and design of materials handling equipment and facilities. Crushing and screening test work conducted in April 1983 confirmed the equipment selection and practical design basis.

3.4.3.4 Scale-Up

The Surface Materials Handling Facilities utilize unit operations and equipment which are identical to those found in the conventional bulk materials preparation and handling industry; therefore, there is no scale-up risk. The Union Oil Company has employed the similar key components and redundancy philosophy in materials preparation facilities at the Parachute Creek Plant. CB personnel will have the advantage of observing the Union Oil Company's equipment in operation some four years prior to start-up at CB.

3.4.3.5 Problems and Risks

Risks associated with the Materials Handling Facilities are similar to those encountered in the conventional bulk materials preparation and handling industry. In general, conventional design practices will be used to mitigate these risks. Some of the characteristic operational risks and design considerations are as follows:

1) Interrupted Mine Supply - Coarse raw shale will be reclaimed from remote storage and transported by truck to the local coarse oil shale pile to offset interruptions.

2) Interrupted Supply from Crushing Plant - Minus 2 inch material will be reclaimed from the fine ore feed storage silo for final screening and feed to the AGR.

3) Problems in Final Screening - Screening plant capacity will be based on three screens, each carrying 50% capacity of the feed. The third screen will be for maintenance and surge capability.

4) Metal Objects in the Feed (drill steel, etc.) - A tramp iron magnet will be installed on the coarse ore reclaim conveyor transferring the rock to the crusher. A metal detector will also be installed over the secondary scalping screen feed belt to prevent tramp metal from entering the crusher or final screening plants.

3.4.4 Raw Shale Characteristics

Raw shale characteristics are described in Table 3.4-1.

3.4.5 Spent Shale Handling

3.4.5.1 Process Description

The spent shale from the Aboveground Retorting Facilities, plus a small amount of raw shale fines will be conditioned and cooled in a moisturizing step prior to disposal. This equipment will be located in the Spent Shale Wetting Facility, directly east of the AGR. The moisturized shale will leave the wetting facility with a moisture content of approximately 16 percent by weight and a temperature of 167°F.

The spent shale will be deposited in two gulches east of the plant. Cottonwood, the western-most gulch, has capacity for 42 million tons of material and will be filled during the first 12.5 years of operation (see Figure 3.4-2).

TABLE 3.4-1

Raw Shale Characteristics

Material Characteristics	Coarse Ore	Fine Ore	Rejects
Bulk Density (lbs/ft^3)			
Loose	75	66	66
Settled	85	72	72
Size Range (inches)	-10x0	-2x1/8	-1/8x0
Maximum Piece Size (inches)	9x12x18	2x3x3	1/8
Moisture Content	2%	1%	-
Minimum Flow Angle; Static	55°	55°	55°
Dynamic	45°	45°	45°
Angle of Repose	39°	39°	39°
Draw Down Angle	55°	55°	55°
Abrasiveness	Mild	Mild	Mild
Mohs Hardness	4 to 5	4 to 5	4 to 5
Conveying Surcharge Angle	20°	20°	20°

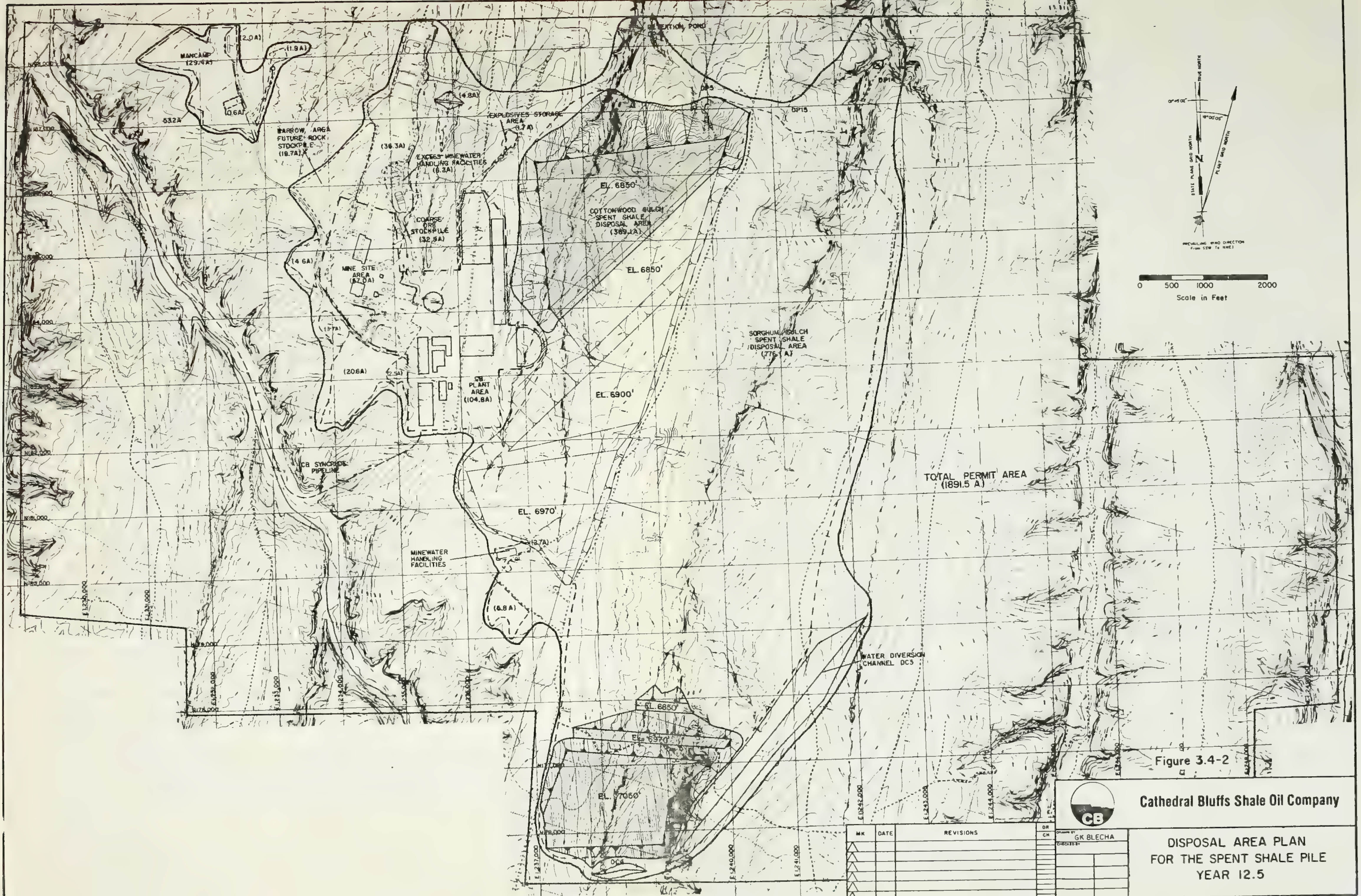


Figure 3.4-2

Cathedral Bluffs Shale Oil Company

MK	DATE	REVISIONS	DR	CH

DRAWN BY GK BLECHA

DISPOSAL AREA PLAN
FOR THE SPENT SHALE PILE
YEAR 12.5

3.4 Materials Handling

The second deposit area, Sorghum Gulch, will accommodate 130 million tons of material, which is sufficient for disposal through Project year 34 (see Figure 3.4-3).

Construction of the processed shale piles will progress from south to north. In Cottonwood Gulch, the pile will start at the head of the gulch, and in Sorghum Gulch, the pile will originate about 1-1/2 miles north of the head of the gulch. The vertical distance from ridges to gulch bottoms is a maximum of about 300 feet. In general, the pile will fill the gulches from ridge to ridge, although in some areas the pile top will be a maximum of about 100 feet above the adjacent ridge.

A ditch will be built at the south end of the Sorghum Gulch pile to divert the runoff from the top of the gulch. This and other drainage features are discussed in Section 6.8.

The disposal piles will consist of three zones of processed shale,* a foundation layer of coarse rock in some areas, and a covering called the reclamation zone. The design of the piles calls for encapsulating the bulk of the spent shale (i.e., Zone II) in a compacted layer of spent shale (i.e., Zone I). In some areas (i.e., Zone III) the shale will be compacted by construction equipment to facilitate the construction of Zone I. The exposed surfaces of Zone I material will be covered with additional spent shale that in turn will be covered with topsoil. The shale will serve as a root zone for revegetation planted in the topsoil. These zones are depicted in Figure 3.4-4.

Major materials handling activities and elements of the spent shale piles are described in the following sections.

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* Section 6.5.3.2.1 describes a 4-5 acre test plot to study disposal and reclamation practice for spent shale. Results from this test may indicate preferable alternatives to the nominal plan described here.

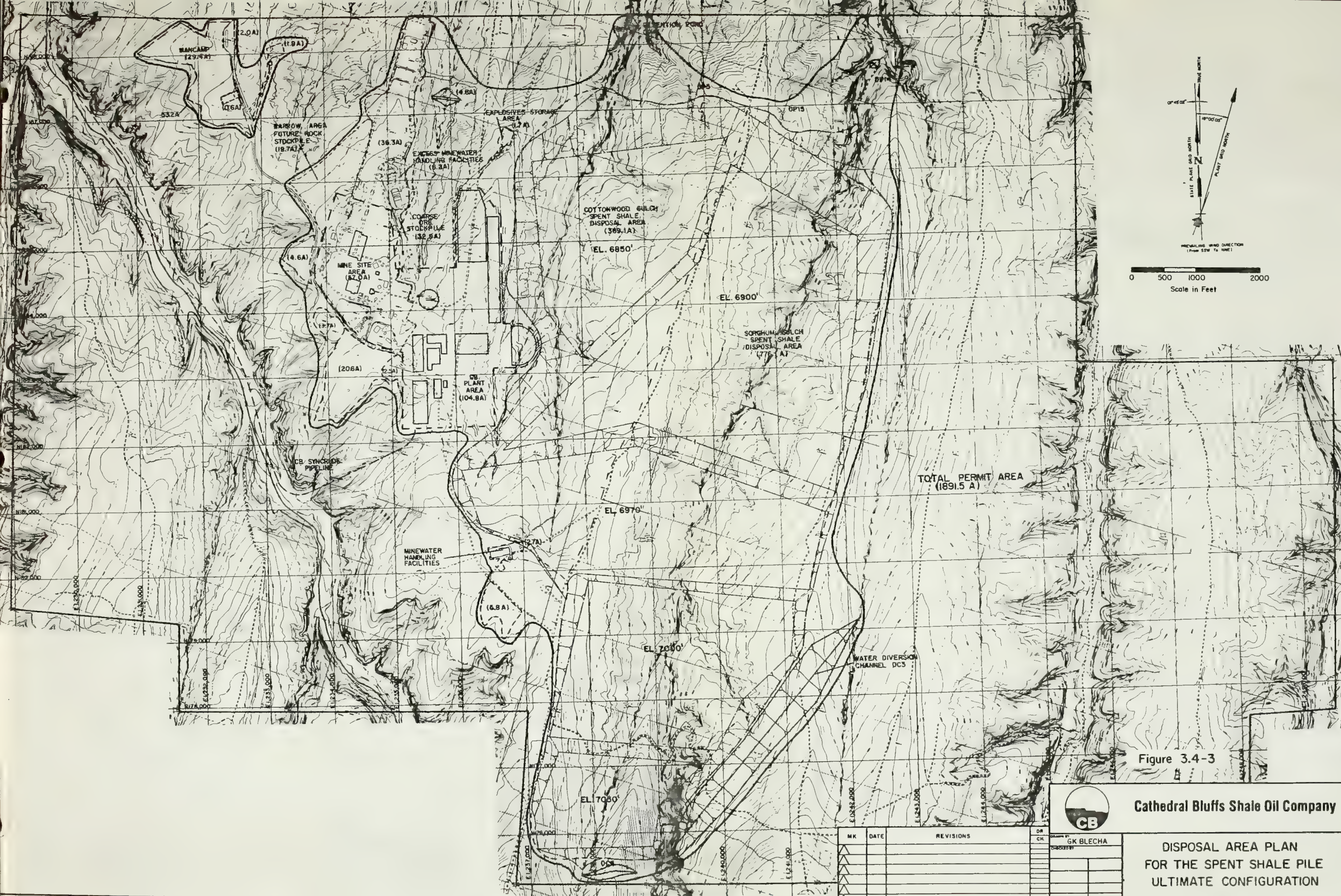
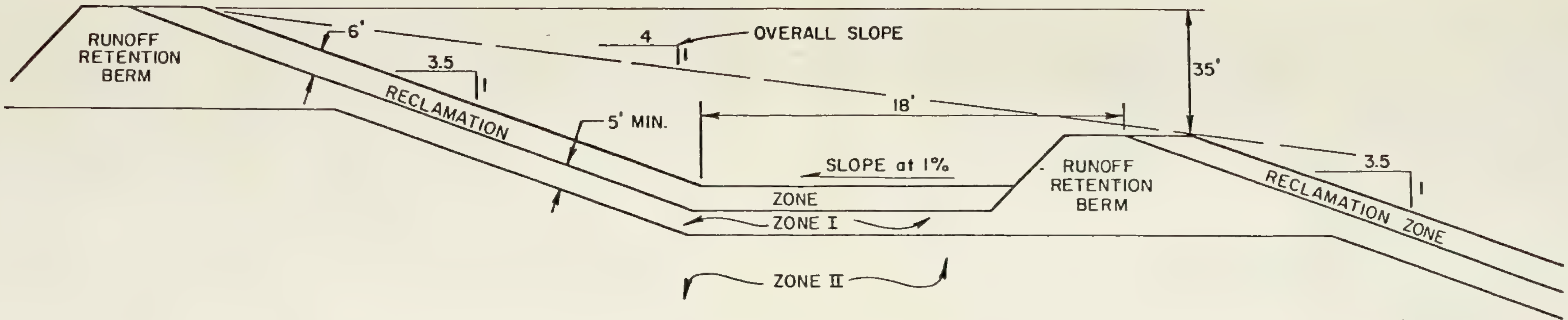


Figure 3.4-3

DISPOSAL AREA PLAN FOR THE SPENT SHALE PILE ULTIMATE CONFIGURATION

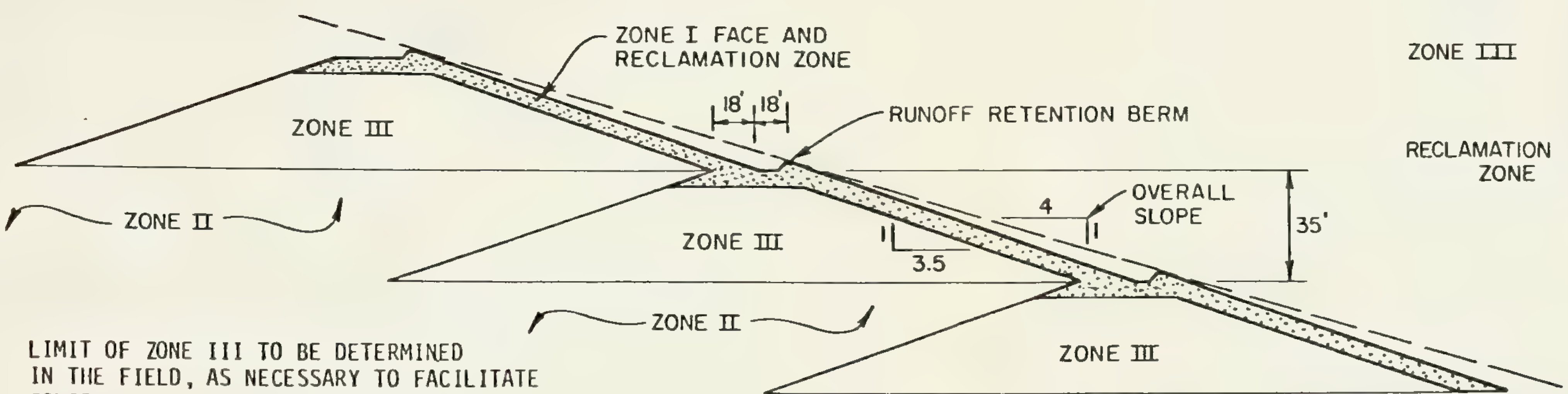


TYPICAL BENCH DETAIL

NOT TO SCALE

DESCRIPTION OF MATERIALS

ZONE I	RETORTED SHALE - PLACED IN 8 INCH THICK MAXIMUM LOOSE LIFTS, AT THE MOISTURE CONTENT OPTIMUM FOR COMPACTION AND COMPACTED TO 100 MAXIMUM DENSITY (ASTM D 1557).
ZONE II	RETORTED SHALE - NO ADDITIONAL MOISTURE OR COMPACTION REQUIRED.
ZONE III	RETORTED SHALE - COMPACTED BY CONSTRUCTION EQUIPMENT ONLY AS NEEDED TO FACILITATE CONSTRUCTION OF ZONE I FACE LINER.
RECLAMATION ZONE	5 FEET OF UNCOMPACTED RETORTED SHALE COVERED WITH A MINIMUM OF 1 FOOT OF TOPSOIL.



NOTE: LIMIT OF ZONE III TO BE DETERMINED IN THE FIELD, AS NECESSARY TO FACILITATE CONSTRUCTION OF ZONE I FACE LINER.

ZONE I FACE DETAIL

NOT TO SCALE

Figure 3.4-4

Job No. : 21120 - 19605	BENCH AND FACE DETAILS FOR SPENT SHALE PILE
Prepared by : K.E.A.	
Date : 4/22/83	

3.4.5.1.1 Top Soil Stripping and Stockpiling

These operations will be performed by mobile earth moving equipment including dozers, front-end loaders and 85-ton rear-dump trucks. As the pile construction progresses down the gulch, topsoil stripped from the ground surface will be stockpiled (see Figures 3.4-2 and 3.4-3) or hauled directly to sections of the pile ready for reclamation.

3.4.5.1.2 Rockfill

The lower portions of the gulches have rough terrain and in some cases are narrow and have steep walls. This terrain will be evened out, first with the use of bulldozers, and then with the placement of coarse rock in 3 ft. thick lifts. The rock will also facilitate natural drainage of minor seeps that may lie under the piles. No such seeps are known to exist in the storage pile areas.

3.4.5.1.3 Zone I

Zone I will be the 5-10 feet thick compacted spent shale blanket that will lie beneath and over the Zone II and III material. Material will be transported by 70-ton bottom-dump trucks from the spent shale wetting facility radial stockpile, or from a windrow that will be generated on the spent shale disposal pile by the totally movable conveyor/stacker. The material will be spread in 8-12 inch thick loose lifts and watered and compacted with mobile equipment, including sheeps-foot compactors. Water trucks will be utilized to raise the moisture content of the spent shale to the optimal level for compaction (about 21 percent). Runoff detention dikes will be constructed at the leading edge of this blanket.

3.4.5.1.4 Zone II

This material represents about 70 percent of the disposal pile and will be conveyed from the spent shale wetting facility by a combination of permanent, semi-permanent, movable, and extendable conveyors. The shale will be deposited along the advancing edge of the pile with moving stackers. The disposal system will consist of extendable conveyors with a mobile stacker with a "finger" that extends into the disposal area at a desired elevation. A track mounted mobile stacker will be constructed which will contain a tripper and stacker belt that will deposit material for 800 feet across the pile on either side of the extendable conveyor.

The Zone II material will be deposited in nominal 50 to 120 foot high uncompacted lifts. Lifts up to a maximum of 150 feet will be deposited in localized areas over gulches. Dozers operating on top of each lift will be used to level the surface and provide a minimal amount of compaction to facilitate movement of the advancing conveyors, stacker, and maintenance vehicles. The finished edges and face will require flattening by benching during the laydown operation with additional distribution by dozers working the pile face in conjunction with the construction of the Zone III material.

The Zone II material will receive incidental compaction (approximately 70 - 85 lb/ft^3) from hauling and spreading equipment. The shale in this zone will not receive additional moistening after initial wetting to cool the shale and control dust. The percent moisture content of the shale when it reaches the disposal area will be approximately 14 percent by weight.

3.4.5.1.5 Zone III

Zone III material will be compacted by hauling or compaction equipment and will be placed only as needed to facilitate the compaction of the adjacent Zone I

material (see Figure 3.4-4). Less than 10 percent of the pile will be comprised of Zone III material.

3.4.5.1.6 Reclamation Zone

The reclamation zone will consist of a root zone of spent shale and a covering layer of topsoil. The shale will be deposited over the Zone I blanket by 70-ton bottom dump trucks and will be used to construct the final side and face slopes of the pile. This zone will be 5-8 feet thick and consist of lightly compacted shale. (The only compaction that will occur is that from hauling and spreading equipment). It will be covered by a layer of topsoil material and will provide additional rooting medium for the vegetation.

A one foot layer of topsoil will be deposited by rear or bottom trucks. Compaction will take place from the hauling and spreading equipment traveling over the material. The material will be spread with dozers or graders.

3.4.5.1.7 Construction of Spent Shale Pile

The spent shale disposal operation will continue on a 24 hour per day basis. Spent shale will be delivered by the retort without any intermediate upstream surge capacity. In case of 1) a breakdown in the spent shale disposal system due to mechanical failures, 2) inclement weather which would force discontinuation of the pile disposal operation, or 3) a need to relocate or rearrange the disposal equipment, moisturized spent shale can be dumped for a 24 hour period on the 10,000 ton capacity emergency stockpile by means of a slewing stacker conveyor. This 24-hour period could be extended indefinitely if front-end loaders and trucks were used to deplete the stockpile.

The development of the various elements of the spent shale pile (e.g., rockfill, Zones I to III, and topsoil) will occur simultaneously. Clearing and

topsoil stripping will precede the advance of the lower Zone I blanket. This blanket will lead the deposit of the Zone II material by an average of 500 feet. The upper Zone I blanket and the overlying reclamation zone will be maintained on the advancing edge of the top of Zone II. The open face of the Zone I, II, and III material will be a maximum of about 200 acres at any given time.

The faces of the pile will have an overall slope of 4:1 and will have benches spaced at uniform intervals (see Figure 3.4-4). The 4:1 slope angle will assure slope stability and facilitate reclamation. The benches will also enhance reclamation and collect surface runoff that may occur before vegetation is established.

3.4.5.2 Environmental Control

The following Environmental Control Plans address processed shale issues:

Section 6.2 - Air Quality
Section 6.3 - Hydrology
Section 6.4 - Water Quality
Section 6.5 - Land Disturbance and Reclamation
Section 6.8 - Erosion

3.4.5.3 Process Selection

Numerous studies have been completed to identify the optimum Spent Shale Handling Facilities. The plans and designs presented were developed during 1983 by Stearns-Roger, Denver.

3.4.5.4 Scale-up

The Spent Shale Handling Facilities utilize unit operations and equipment which are identical to those found in the conventional bulk materials preparation and handling industry; therefore, there is no scale-up risk.

3.4.5.5 Problems and Risks

Risks associated with the Spent Shale Handling Facilities are similar to those encountered in the conventional bulk materials preparation and handling industry. In general, CB plans to use conventional design practices to mitigate these risks.

3.4.6 Spent Shale Characteristics

Spent Shale characteristics are confidential.

3.4.7 Utility Requirements

3.4.7.1 Raw Shale Handling

Utility requirements for the handling of raw shale are described in Table 3.4-2.

3.4.7.2 Spent Shale Handling

Utility requirements for the handling of Spent Shale are described in Table 3.4-3.

TABLE 3.4-2

Utility Requirements - Raw Shale Handling

Fuel Consumption, MM BTU/hr	None
Power Consumption, KW:	
Conveyors/Stackers	845
Crushing	149
Screening	90
Dust Collection	471
Cranes and Monorails	10
Sump Pumps	10
Ventilation Fans and Samplers	27
Total	1,602
Emergency Power	None
Plant & Instrument Air (intermittent), SCFM	600
Nitrogen, SCFM	None
Steam Consumption Production, M lbs/hr	None
Condensate Production, M lbs/hr	None
Cooling Water, GPM	None
Dust Suppression Water, GPM	4
Service Water, GPM	1
Boiler Feed Water, GPM	None

TABLE 3.4-3

Utility Requirements - Spent Shale Handling

Diesel Fuel Consumption, gal/day	850
Power Consumption, KW:	
Permanent Conveyors	180
Stockpile Conveyors/Stackers	160
Sump Pumps	5
Total	345
Emergency Power	None
Plant & Instrument Air (intermittent), SCFM	100
Nitrogen, SCF	None
Steam Consumption Production, M lbs/hr	None
Condensate Production, M lbs/hr	None
Cooling Water, GPM	None
Dust Suppression Water, GPM	5
Service Water, GPM	1
Boiler Feed Water, GPM	None
Zone I Compaction Water, GPM	33[a]
Revegetation Water, GPM	-[b]

[a]Varies 7 to 41 during years 2-34.

[b]Varies 133 to 205 during years 3-34 (summer months only).

3.0 PROJECT DESCRIPTION

3.5 Aboveground Retorting (AGR) Facilities

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3.5 Aboveground Retorting (AGR) Facilities

3.5.1 Introduction/Summary

The first phase of the CB Project will employ the Union Oil Company's (Union) proprietary Unishale B Retorting technology to retort raw shale produced from the Room and Pillar Mine as well as the development of the MIS Mine. The retort unit will be identical to Union's Parachute Creek Plant. However, any modifications made during the initial operation of the Parachute Creek Plant will also be included in the CB Project.

3.5.2 Schedule

The schedule for the engineering design, construction, start-up, and operation of the AGR Facilities is shown in Figure 3.2-1.

3.5.3 Process Description

The Aboveground Retorting Facilities consist of three major units: Retort and Spent Shale Cooling, Fractionation, and AGR Sulfur Recovery Unit. The overall block flow diagram for the AGR Facilities is shown in Figure 3.5-1.

3.5.3.1 Retort and Processed Shale Cooling

The Unishale B Retort processes approximately 11,800 TPCD of raw shale on a dry basis, equivalent to approximately 11,900 TPCD on a wet basis with 1% moisture. A unique piston feeder system called a "rock pump" feeds shale to the retort in an upflow direction. The current plan targets having the Fisher assay grade of the raw shale fed to the retort average 40 GPT. Hot recycle gas flows counter current to the shale in the retort and provides the heat for retorting the kerogen from the oil shale. The retort will produce approximately 11,000 BPCD of raw shale oil, under steady-state conditions; to this value, 2,260 BPCD of MIS oil are added for a total raw shale oil output of 13,260 BPCD (Figure 3.5-1). A significant quantity of high-BTU gas will also be produced.

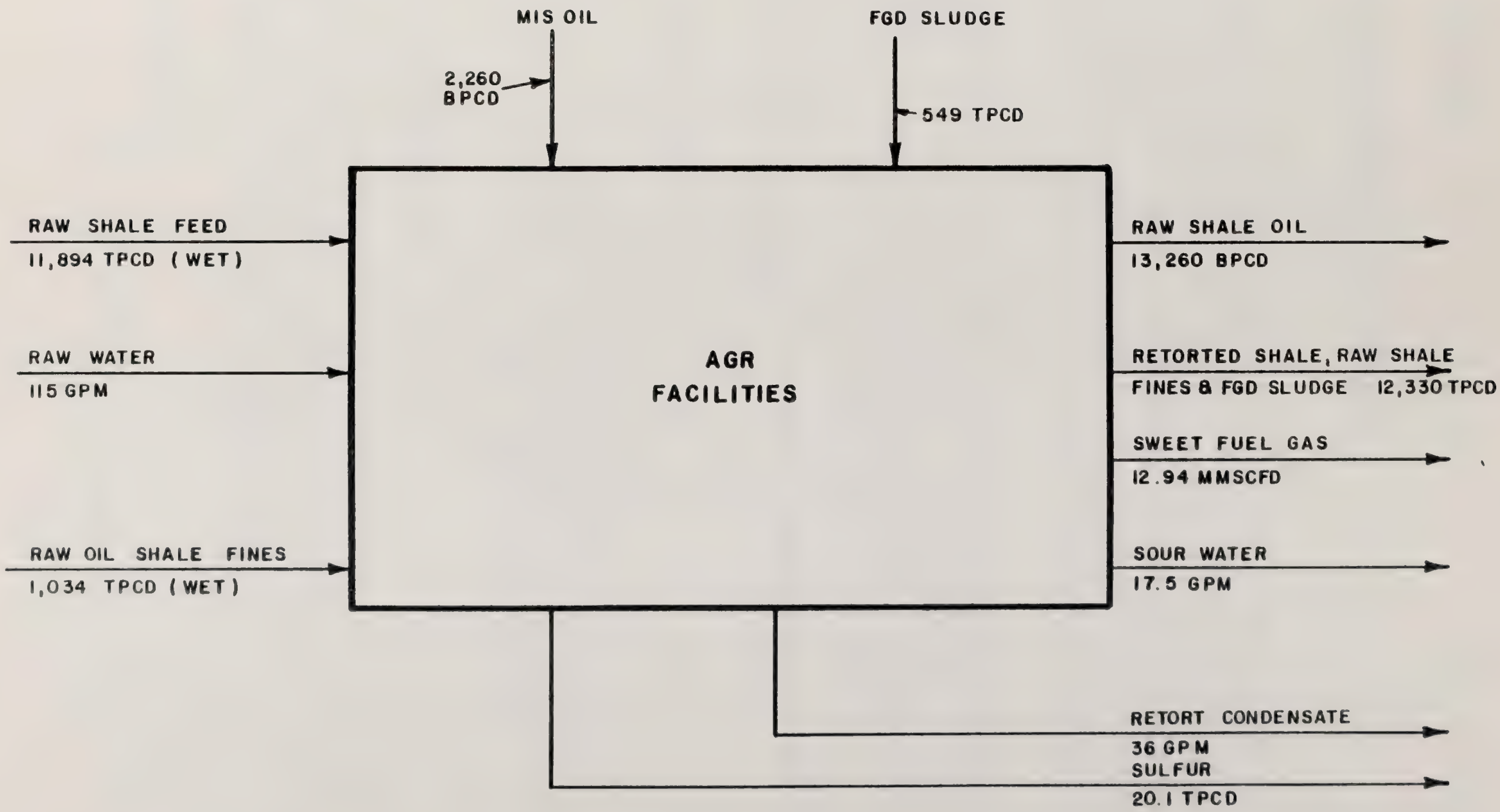

FIGURE 3.5-1

OVERALL BLOCK FLOW DIAGRAM FOR ABOVEGROUND RETORTING FACILITIES

3.5 Aboveground Retorting (AGR) Facilities

The spent shale exiting the retort will be cooled with water, mixed with raw shale fines and Flue Gas Desulfurization (FGD) sludge from the MIS Process Facilities and then moisturized in the Wetting Facilities for optimum compaction. Process or other raw water streams produced within the plant will be used for moisturizing the processed shale. For details refer to water balance, Figure 3.8-2. The moisturized shale will then sent to the Processed Shale Disposal Facilities.

The high-BTU make gas from the retort is treated to remove C_5+ material and then scrubbed with water to remove ammonia. The sour water will be sent to the sour water stripper in the OUG Facilities for treatment. The ammonia-free gas will then be sent to the AGR Sulfur Recovery Unit for H_2S removal.

The retort condensate will be sent to the foul water stripper located in the MIS Process Facilities for treatment.

3.5.3.2 Fractionation Unit

Raw shale oil produced in the Unishale B Retort along with the MIS oil will be processed in the Fractionation Unit to remove ash, emulsified water (if any), and light hydrocarbons. The stabilized C_5+ product produced in this unit will then be sent to the OUG Facilities to produce a high quality syncrude.

3.5.3.3 AGR Sulfur Recovery Unit

The ammonia-free AGR make gas will be treated in Union Oil's proprietary Unisulf process to remove H_2S prior to its use in the plant fuel gas system. An overall H_2S recovery of 99.9% is accomplished with this process. The sulfur produced will be melted and the stored in a molten state.

3.5.4 Utility Requirements

The utility requirements for the AGR Facilities are shown in Table 3.5-1.

TABLE 3.5-1

AGR Overall Utility Requirements*

Utility	AGR Retorting & Shale Cooling	Fractionation Unit	AGR Sulfur Rec. Unit	Total
Fuel Gas Consumption (MM BTU/Hr)	255	-	-	255
Power Consumption (KW)	4,505	360	2,215	7,080
Emergency Power (KW)	410	-	-	410
Plant and Instrument Air (SCFM)	140	115	115	370
Inert Gas (SCFH)	8,740	550	-	9,290
Steam Consumed (M lb/hr)				
600 psig, 750°F	103.8	1.3	-	105.1
150 psig, Sat.	9.3	0	0.4	9.7
50 psig, Sat.	16.8	0	3.6	20.4
Condensate	-	0	4.0	4.0
Steam Produced (M lb/hr)				
150 psig	48.6	-	-	48.6
50 psig	9.3	-	-	9.3
Condensate (cold)	55.3	-	-	55.3
Condensate (hot)	4.0	1.5	3.5	9.0
Cooling Water (GPM)	3,190	1,480	60	4,730
Service Water (GPM)	11.0	84.3	2.8	98.1
Boiler Feed Water (GPM)	0	0.5	0	0.5
Raw Water (GPM)	115	-	-	115

* Based on 11,000 BPCD of raw shale oil production from the AGR Facilities, 2,260 BPCD of raw shale oil from the MIS Facilities, and processing 13,260 BPCD through the Fractionation Unit.

3.0 PROJECT DESCRIPTION

3.5 Aboveground Retorting (AGR) Facilities

3.5.5 AGR Retort Process Variables

This application was compiled and filed with the limited information from Union Oil Company of California that is available before its Parachute Creek AGR facility has undergone all of the adjustments that might be appropriate in connection with its commercial scale operations. Further information is expected within the next few months, but even after that time, data updates will be received and studied. It is thus apparent that a number of process factors could change.

For example, while it is the Project's objective to design and operate the AGR with 40 gpt shale, there is a definite possibility that optimum operation may eventually be determined to be on leaner shale. This further firming of process variables could ultimately affect the percentage of fines to be handled with the spent shale, the overall water balance, the sulfur emissions and/or the sizing of the upgrader.

CB will advise and consult with the OSPO if the receipt and analyses of future data and studies dictate any course different than that stated herein.

3.0 PROJECT DESCRIPTION

3.6 MIS Processing Facilities

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3.0 PROJECT DESCRIPTION

3.6 MIS Processing Facilities

3.6.1 Introduction/Summary

The MIS Process Facilities included in the design are the product of ten years of developmental work. The successful operation of Retorts 7 and 8 at Occidental's Logan Wash test site was the culmination of this effort. The boiler, Flue Gas Desulfurization Units, and Foul Water Stripper are well-demonstrated, commercially available process designs.

Two distinctly different crude oils are produced by the MIS process. Bulkhead oil is collected underground at the retort Product Level and a lighter oil is collected from the Offgas Processing System on the surface. The combined oil production of stock tank oil will be 2,260 barrels per calendar day (BPCD). Figure 3.6-1 presents the overall block flow diagram for the MIS Process Facilities.

Under steady-state conditions, a cluster of four retorts will be constructed as a unit. The process is designed to burn five retorts per year, with four in operation at any given time. The burn period per retort will be 292 days, requiring start-up of a new retort and shutdown of an exhausted retort every 73 days. The retorts have a height of 278 ft. and are 165 ft. square.

Two primary product streams will be produced underground at the Product Level bulkheads. The first will be an oil-water mixture that will be demulsified and separated underground. The bulkhead oil will be pumped to the surface, while the water will be used underground for cooling sprays and spent retort quenching. During the initial MIS operation before there are any spent retorts, the MIS retort water will be used for moisturizing the AGR spent shale. The second product stream will be the offgas, which will be routed to the Offgas Processing System. The offgas will contain oil

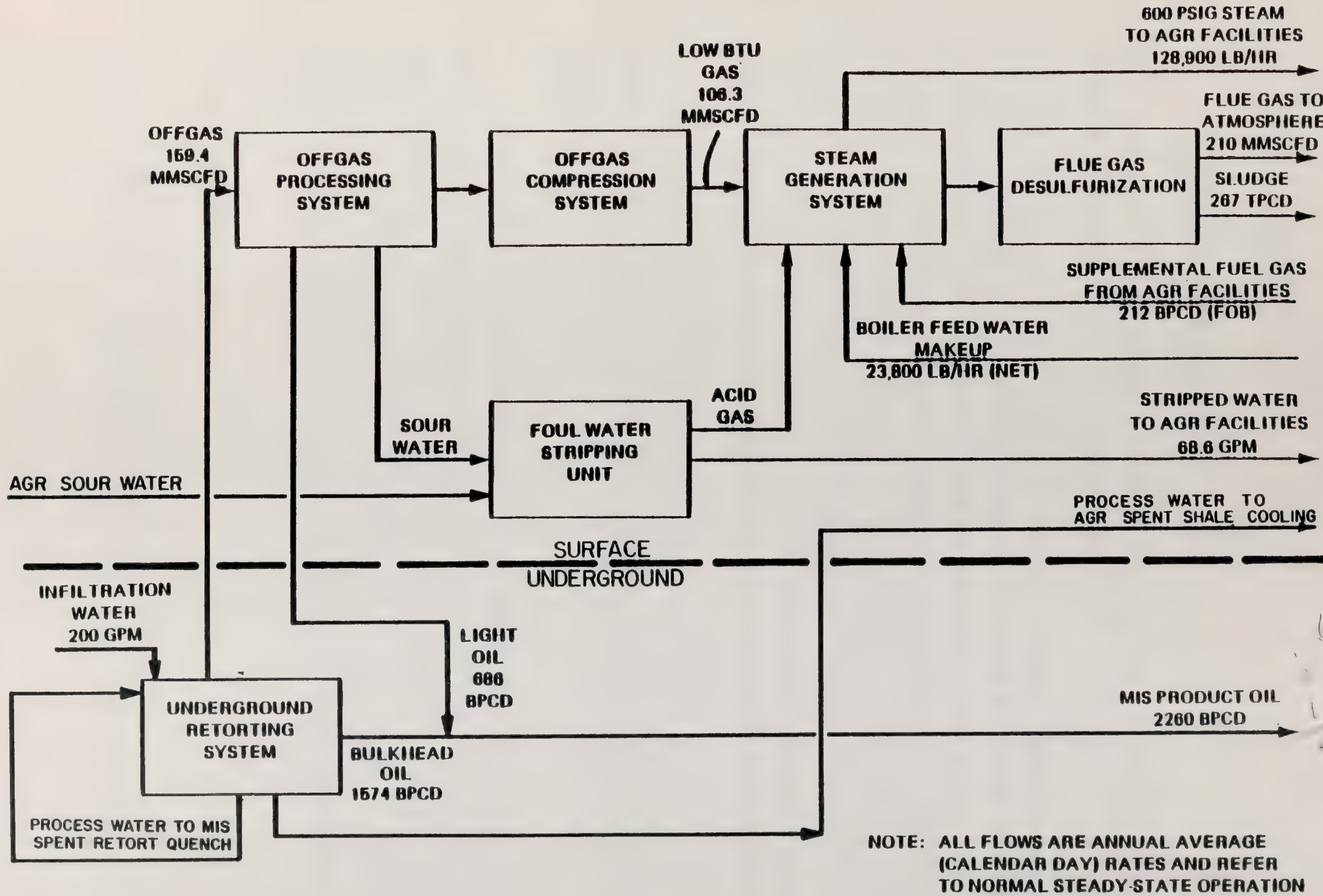

FIGURE 3.6-1 Block Flow Diagram for MIS Process Facilities

from condensible C_5+ oils down to lighter hydrocarbons, hydrogen, and carbon monoxide fuel gases as well as large quantities of inerts.

The Offgas Processing System will include a contact condenser unit and a sponge oil absorber unit. All the aerosol oil and 75% of the C_5+ oil, as well as water vapor will be condensed out of the offgas by these units. The oil collected in the Offgas Processing System will be combined with the crude oil collected at the bulkheads and sent to the Fractionation System of the AGR Facilities. The water will be returned to the Underground Retorting System for quenching or sent to a Foul Water Stripping Unit for sour gas removal prior to recycling. The net water make will be a low-total-dissolved-solids process water which will be used for process make-up and processed shale cooling and wetting.

The offgas from the Offgas Processing System will be compressed by compressors in the Offgas Compression System. Sub-atmospheric pressures exist in the retorts as a result of the retorts being connected to the suction side of the compressors.

The MIS offgas, after processing, is a low-BTU (69 BTU/SCF LHV) gas. It will be burned in the Steam Generation System to meet the steam requirements of the total plant. Sour gases from the Foul Water Stripping Unit will be combusted in reducing burners in the Steam Generation System. The flue gas exhaust from the Steam Generation System will be processed in a double alkali Flue Gas Desulfurization Unit to reduce the SO_2 concentration to meet emissions standards.

3.6.2 Schedule

The schedule for the engineering design, construction, start-up, and operation of the MIS Process Facilities is shown in Figure 3.3-4.

3.6 MIS Processing Facilities

3.6.3 Process Description

The MIS process facilities are divided into six areas:

Underground Retorting System
Offgas Processing System
Offgas Compression System
Steam Generation System
Flue Gas Desulfurization (FGD) Unit
Foul Water Stripping Unit

3.6.3.1 Underground Retorting System

The MIS underground retorts operate in a batch mode. Once steady-state is reached with four retorts in operation, every 73 days a new retort will be ignited and an exhausted retort will be shut down. The exhausted retort, after shut down, will go through a quench cycle that will last roughly 10 months (see Section 3.3).

The Underground Retort Process Facilities will separate oil and water produced at the bulkheads and deliver the oil to the surface facility. The offgas will be collected in hard piping for delivery to the Offgas Processing Facility. Produced water will be collected and reused as cooling spray water and quench water (though there is a net production via offgas processing). A Hot Inert Gas Generator (HIGG) will supply hot inert gas for ignition.

3.6.3.1.1 Construction (Bulkhead and Piping)

After a retort is rubblized, piping, bulkheads and other equipment will be installed. Refer to Section 3.3.6 for details.

3.6 MIS Processing Facilities

The MIS section of the mine is designed to provide access for people and materials. At the Product Level, oil, water, and offgas lines will be hard-piped from each retort bulkhead. The offgas lines will be manifolded in the Product Level drifts, and offgas will be collected in the main drift for transport to the surface in the cased offgas raise.

The underground liquid product piping will discharge to an oil/water separation tank. Vapors from the tank will vent to the offgas raise. The oil will be pumped to the surface.

The HIGG will be moved from retort to retort on the Upper Level for ignition. The combustion air blower will be installed at the entrance to each cluster and piped to the HIGG. Support pumps, piping, and instrumentation will be modularized and skid mounted for easy installation and movement.

The system is designed to minimize construction for each new cluster by extending the piping, electrical, and instrumentation system as the retorting progresses. All techniques and equipment will utilize proven designs, most of which have been employed on Retorts 7 and 8 at Logan Wash.

3.6.3.1.2 Ignition

The objective of the ignition phase is to establish a uniform combustion zone across the entire retort. Ignition or start-up of a retort requires the following actions:

- Purging the air (oxygen) from the retort voids into the offgas ducts in a safe manner;

- Rapid and uniform heating of the top surface of the rubble column, using hot inert gas at the temperature at which combustion will occur;
- Introducing air to initiate and establish the combustion zone; and
- Subsequent cooling of the plenum to retard roof sloughing.

A retort will be ignited every 73 days. The HIGG will be used for ignition and is identical to the one used successfully for Retorts 7 and 8 ignition. The HIGG is a horizontally fired burner system with a refractory lined chamber and is designed to produce inert gas by the stoichiometric combustion of shale oil or diesel fuel.

3.6.3.1.3 Underground Retorting System

Following ignition, the burner system will be moved from the retort and replaced with an inlet air pipe containing a flow control valve. With the combustion zone established, the reaction of the oxygen with residual carbon and residual oil on the shale will provide hot gases that pyrolize the kerogen into vaporized shale oil and pyrolysis gas. The average air flow rate will advance the retorting zone about 0.9 feet per day. At this rate, the retort will operate 292 days.

The retort vapors will flow downward in the retort, drawn by the surface compressors. The total retort will be maintained under sub-atmospheric pressure to ensure that retort gas will not flow into the main ventilation air. Differences in pressure drop between retorts operating simultaneously will be balanced by use of a valve on the retort offgas line at the bulkheads and/or by control of the air inlet valve.

3.6 MIS Processing Facilities

As the retorting progresses, the temperature of the offgas will increase from mine ambient temperature to a steam temperature plateau. The temperature will then stay constant during most of the retort operation. As the retorting front approaches the bottom, the offgas temperature will rise. A water spray system will be installed on all retorts at the Product Level bulkheads to control the offgas temperature.

When the retorting front reaches the bottom of the retort, the air is shut off and the processed shale will have considerable stored heat. If this heat were permitted to remain in the rubble after retorting, it would transfer to the pillars resulting in a degradation of the pillar strength. Therefore, quench water will be injected at the top of the retort to cool the retorts and maintain mine stability.

The quench operation will last approximately 10 months per retort. It will improve the offgas heating valve, produce lower total-dissolved-solids water, and improve the overall process water balance by consuming low-quality produced water.

3.6.3.2 Offgas Processing System

The Offgas Processing System will first cool the MIS offgas stream, condensing water vapor, and removing oil mist and ammonia from the stream. It will then subject the cleaned gas stream to refrigerated sponge oil to recover C_5+ hydrocarbons. Refrigeration will be supplied by means of an ammonia-water absorption refrigeration unit, utilizing low level heat in the form of steam. The condensed oil/water mixture will be pumped to the aerosol settling tank, provided with an internal steam coil to promote separation of water and oil.

The sour water will be sent to the Foul Water Stripping Unit for treatment prior to its use as process water. A surge tank will also be included in these surface facilities that will hold retort water from the underground oil/water settling drum as well as excess stripped water and will provide water for underground processing. The condensed C_5+ oil will join the bulkhead oil, the oil recovered from the aerosol settling tank and the Foul Water Stripper surge tank. It will then be sent to the Fractionation Unit in the AGR facilities for deashing in order to meet specifications for the Oil Upgrading Facility.

3.6.3.3 Offgas Compression System

The Offgas Compression System compresses the clean MIS retort offgas from the Offgas Processing System so that it can be used as fuel in the utility boilers at the Steam Generation Plant.

The system will consist of two 50% parallel centrifugal compressors with individual suction knockout drums. For reliability, one compressor will be steam driven, the other motor driven. Power will be suplied by imported electrical power.

3.6.3.4 Steam Generation System

The MIS area boilers are designed to burn MIS offgas, excess plant fuel gas, stripper overhead gas and natural gas. They also will incinerate Claus tail gas from the oil upgrading area.

The combustion section of the boiler is split in two sections: one section is composed of a low NO_x combustor taking stripper overhead gas, excess plant fuel gas and a sub-stoichiometric quantity of air to partially oxidize ammonia to N_2, H_2O and H_2. Combustion products from this section enter the main combustion chamber along with additional air, MIS gas and Claus tail gas for

final complete combustion. Combustion products from the main combustion burner supply the heat to the steam generation section of the boiler. The boiler design is such that additional steam can be produced by supplementing the MIS gas with natural gas as required. The combustor is designed such that the low BTU MIS offgas can be combusted without supplemental fuel other than that required for pilot gas and NO_x control.

3.6.3.5 Flue Gas Desulfurization System

The Flue Gas Desulfurization (FGD) System will reduce the SO_2 content of the boiler flue gas prior to discharge into the atmosphere. A dual alkali FGD with two parallel absorbers will be used. Each absorber will contain two scrubbing sections and appropriate mist elimination. Exiting flue gas will pass through a reheater prior to discharge to a common stack in order to enhance plume buoyancy.

Spent scrubbing solution from the absorbers is regenerated in two parallel regeneration trains. The resultant waste calcium sulfite slurry will be slurried with waste water and pumped to the Spent Shale Disposal area for disposal with the spent shale. Chemicals required for the FGD operation (lime and soda ash) will be supplied to truck off-loading areas for storage and use as needed.

3.6.3.6 Foul Water Stripper

The Foul Water Stripper section will receive AGR condensate, sour process condensate from the direct condenser and other equipment in the offgas processing section. The combined water will be treated further to remove oil and sludge, and ammonia will be stripped out so that the water can be recirculated to the contact condenser and fed to the Flue Gas Desulfurization Unit. The remaining stripped water will be used for processed shale wetting. Provision has been made to route the first stage deasher effluent to this facility for treatment in the event it is needed.

3.6 MIS Processing Facilities

The foul water feed stream will contain dissolved ammonia, carbon dioxide, and light organics with lesser quantities of hydrogen sulfide, carbon monoxide, and other contaminants, and will contain less than 10 ppm of free oil.

The overhead gas from the sour water stripper will contain primarily NH_3 and CO_2, with lesser quantities of H_2S, CO, light organics, and other contaminants. It will be passed to special reducing burners in the boilers, where the ammonia will be converted to N_2, and H_2O, and then other combustibles will be burned. The stripped sour water from the bottom of the tower will contain less than 50 ppm of free ammonia.

3.6.4 Utility Requirements

The overall utility requirements for the MIS Process Facilities are shown in Table 3.6-1.

TABLE 3.6-1

Overall Utility Requirements for MIS Process Facilities

Utility	MIS Underground Processing	Offgas Processing	Offgas Compression	Steam Generation	Flue Gas Desulfuri-zation	Foul Water Stripping	Total
Fuel Produced, MM BTU/hr	0	1.0	297.3	(358.3)[1]	0	0	(60.0)
Power Consumption, KW	526	1172	1991	581	959	244	5473
Plant and Instrument Air, SCFM							200
Steam Consumed, M lbs/hr							
600 psig	0	30.2	18.6	59.5	12.2	0	120.2
250 psig	0	33.1	0	7.7	6.7	53.4	106.5[3]
Condensate	0	0	6	252.4	0	0	252.4
Steam Produced, M lbs/hr							
600 psig	0	0	0	267.0	0	0	267.0
85 psig	0	10.8	0	59.5	12.2	0	82.5
Condensate	0	57.1	18.9	4.6	6.7	53.4	140.1
Cooling Water, GPM[4]	0	14081	84	0	0	1269	15434
Boiler Feed Water Consumed, GPM	0	0	0	99.8[2]	0	0	99.8
Service Water, GPM	0	0	0	0	52.5	0	52.5
Blowdown Produced, GPM	0	0	0	7.6	0	0	7.6

1 ( ) indicates consumption of fuel by boilers

2 Makeup demineralized water

3 Includes 5.6 M lb/hr for total area consumption and loss

4 Recirculation rate

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3.7 Oil Upgrading Facilities

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3.7 Oil Upgrading Facilities

3.7.1 Introduction/Summary

The Union Oil Company's proprietary oil upgrading technology has been selected to hydrotreat the raw shale oil to produce a high quality syncrude which will meet specifications for pipelining and conventional refinery feed stock. The Oil Upgrading (OUG) Facilities will be designed to process approximately 13,260 BPCD of raw shale oil produced from AGR and MIS Process Facilities and produce about 14,100 BPCD of syncrude.

3.7.2 Schedule

The schedule for the engineering design, construction, start-up, and operation of the OUG Facilities is shown in Figure 3.2-1.

3.7.3 Process Description

The Oil Upgrading Facilities will consist of four major units: Hydrotreating Unit, Hydrogen Unit, Sour Water and Sour Gas Treating Unit, and OUG Sulfur Recovery Unit. The overall block flow diagram for the OUG facilities is shown in Figure 3.7-1.

3.7.3.1 Hydrotreating Unit

The Union Oil Company's proprietary oil upgrading technology will be used to hydrotreat the raw shale oil produced from the AGR and MIS Process Facilities. This process employs severe hydrotreating to yield a high quality syncrude with low levels of nitrogen, sulfur, and arsenic, which can be conveyed in existing pipeline networks and can be processed in existing refineries without extreme modifications.

The Hydrotreating Unit will produce sour water and sour gas which will be treated in the Sour Water and Sour Gas Treating Unit. The sour water,

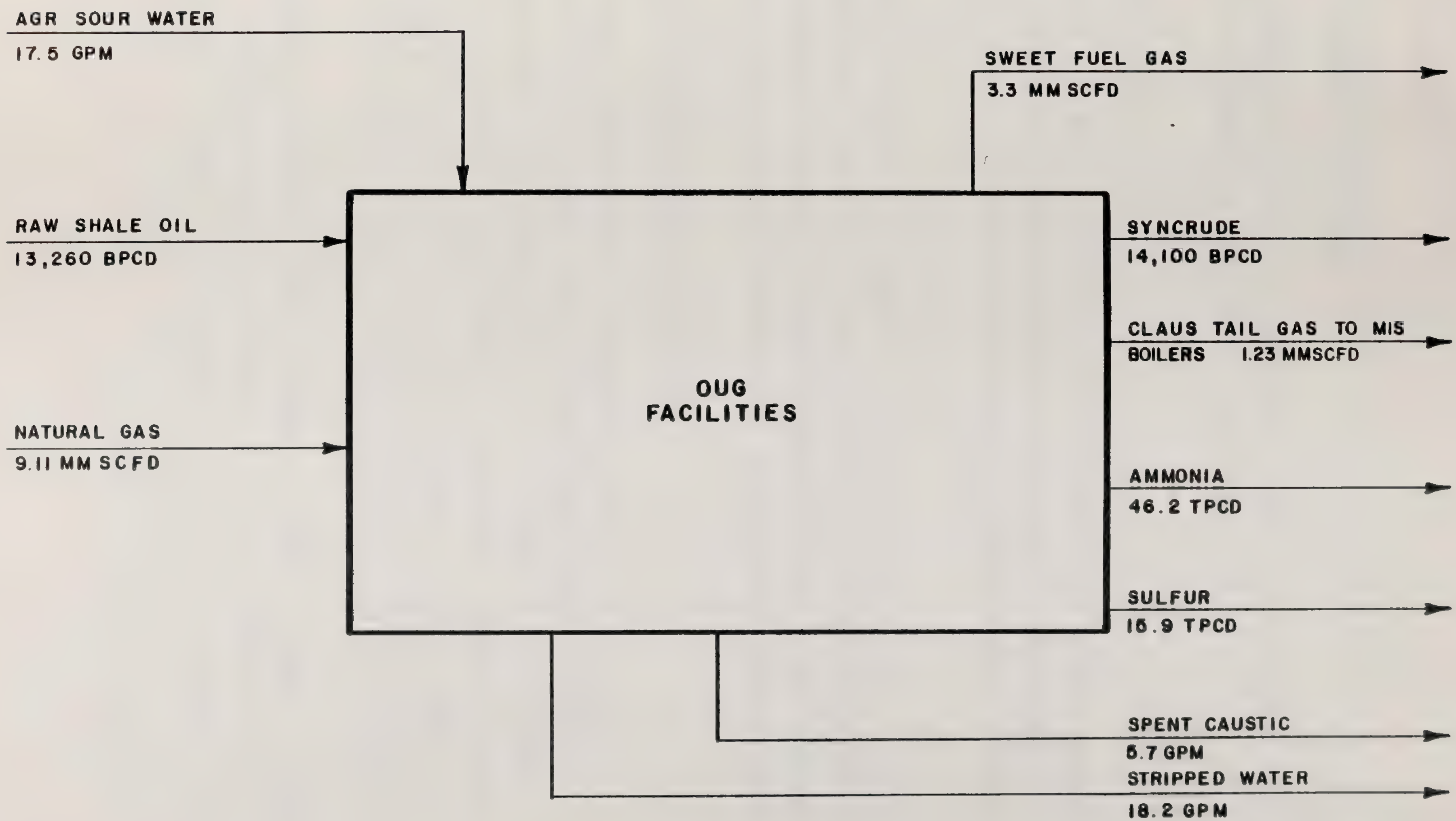

FIGURE 3.7-1

OVERALL BLOCK FLOW DIAGRAM FOR OIL UPGRADING FACILITIES

after being treated, will be reused as wash water within the Hydrotreating Unit. The sour gas after treatment will be used as plant fuel gas.

3.7.3.2 Hydrogen Unit

The Hydrogen Unit will use natural gas as a feedstock to produce hydrogen for the Hydrotreating Unit. The Hydrogen Unit will employ a conventional steam-methane Reformer and Pressure Swing Adsorption (PSA) System to produce 99.9% pure hydrogen.

The Hydrogen Unit will also contain a Reformer waste heat recovery section to produce high pressure steam used within the process. A significant portion of the excess high pressure steam will be used to drive the natural gas compressor and meet a large portion of the steam demand in the sour water treating section.

3.7.3.3 Sour Water and Sour Gas Treating Unit

The sour water, containing large quantities of NH_3 and H_2S produced in the Hydrotreating Unit, along with small volumes of sour water from AGR Facilities and the OUG Sulfur Recovery Unit will be routed to a sour water stripper. In the stripper, the sour waters will be steam stripped to remove dissolved NH_3, H_2S, CO_2, and volatile dissolved organics. The stripped water will then be reused in the hydrotreating area as wash water and the remaining excess stripped water will be sent to other users within the plant.

The sour gases from the sour water stripper overhead will then be routed to a Phosam Unit, licensed by U.S. Steel Corporation. In the Phosam Unit, the ammonia from these sour gases will be removed by use of a lean phosphoric acid solution in a Phosam liquid absorber. The ammonia free sour gas will then be routed to the OUG Sulfur Recovery Unit for H_2S removal. The rich phosphoric

acid will be regenerated for reuse, and the ammonia will be recovered as anhydrous ammonia suitable for sale.

The sour gas from the Hydrotreating Unit will also be treated in a separate Phosam Gas Absorber to remove ammonia. The ammonia free gas containing small quantities of H_2S will be sweetened by caustic wash. The sweet gas will then be sent to the Plant fuel gas system. The spent caustic will be routed to the spent shale cooling and moisturizing sections.

3.7.3.4 OUG Sulfur Recovery Unit

The sour gases from the Phosam Liquid Absorber will be directed to a conventional Claus plant to convert H_2S into elemental sulfur. An overall H_2S removal of 97% will be achieved in this Unit. The Claus tail gas will be piped to the MIS boilers for incineration prior to being desulfurized in the Flue Gas Desulfurization Unit.

The molten sulfur from the condensors will be sent to storage. A small quantity of sour condensate condensed from the feed sour gas will be sent to the Sour Water Treating Unit.

3.7.4 Utility Requirements

The utility requirements for the OUG Facilities are shown in Table 3.7-1.

TABLE 3.7-1

OUG Overall Utility Requirements*

Utility	Hydrogen Unit	Hydro-Treating Unit	Sour Water Treating	OUG Sulfur Recovery Unit	TOTAL
Fuel Gas Consumed (MM BTU/hr)	108	32	0	0	140
Natural Gas Consumed (MM BTU/hr) (LHV)	352	-	-	-	352
Power Consumption (KW)	135	5,570	235	60	6,000
Plant and Instrument Air (SCFM)	140	140	110	55	445
Nitrogen (SCFM)	-	5	5	-	10
Steam Consumed (M lbs/hr)					
600 psig	0	0	45.1	0.3	45.4
50 psig	0	0	7.3	0	7.3
Steam Produced (M lbs/hr)					
600 psig	138.6	0	0	4	142.6
150 psig	50.1	0	0	0	50.1
50 psig	47.8	0	0	0	47.8
Condensate	0	0	53.1	0.3	53.4
Cooling Water (GPM)	415	954	221	23	1,613
Boiler Feed Water Consumed (GPM)	86	0	14	8	108
Service Water (GPM)	0	0	3	0	3

* Based on 13,260 BPCD combined AGR/MIS feed operation.

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3.8 Utilities and Off-site Facilities

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3.8 Utilities and Off-site Facilities

3.8.1 Introduction/Summary

The development of the Tract for a commercial oil shale project will require utilities and other facilities to support the mining and above ground activities described in the previous sections. The following subsections address utilities and off-site facilities that are proposed, as well as those that have already been developed. Environmental issues related to off-site facilities and corridors are addressed in Section 6.16.

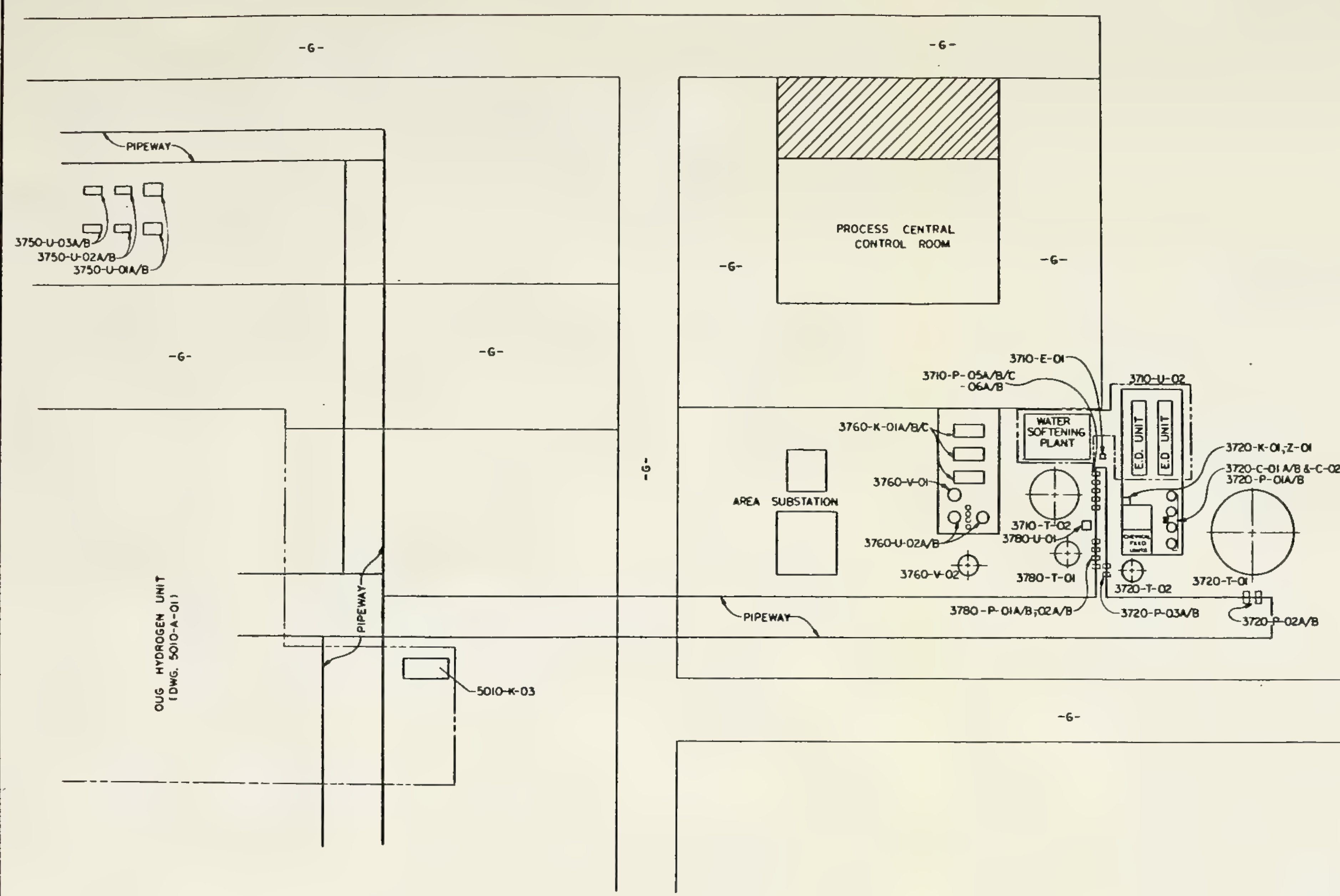
The utilities will be located throughout the Plant area. Location of each subsystem has been based on the proximity of raw material necessary to operate the subsystem or on the proximity of associated units. For example, the Steam Generation System will be located within the MIS Process Facilities area primarily because the boilers will be fueled by low-BTU MIS gas produced in the MIS retorts.

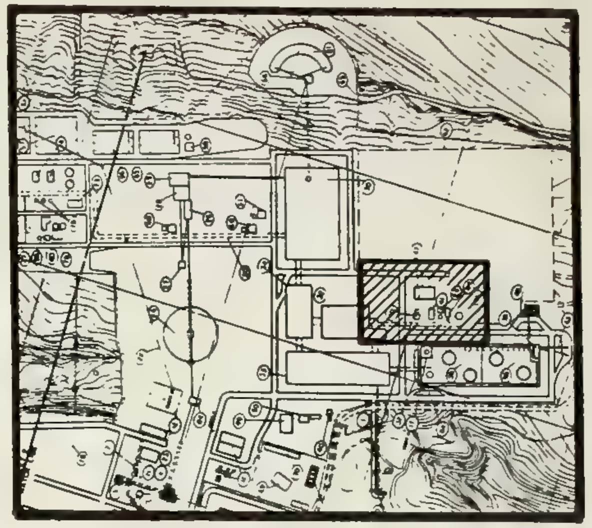
The plot plans for the CB Plant and the Mine Support Area appear in Section 3.2 (Figures 3.2-3 and 3.2-4, respectively). The utility plot plan is depicted in Figure 3.8-1.

Several Sections below address water and stream generation and use. The overall Plant water balance is shown in Figure 3.8-2.

3.8.2 Water Supply Facilities

The overall plant water requirements will be met by mine water produced at the Tract during the mine dewatering operation. For the production of 14,100 BPCD of syncrude, water produced by dewatering will exceed the demand for plant make-up water and the excess mine water will either be discharged to the Piceance Creek, reinjected after filtration, or used for irrigation by sprinkling.





VICINITY MAP
No Scale

EQUIPMENT LEGEND

3710-T-02	Partially Treated Mine Water Tank
3710-E-01	Electrodialysis Unit Preheater
3710-P-04A/B/C	BFW System Feed Pumps
3710-P-06A/B	Regeneration Pumps
3710-U-02	Electrodialysis and Pretreatment Package
3720-T-01	BFW Makeup Tank
3720-T-02	Sulfuric Acid Storage Tank
3720-V-01A/B	Strong Acid Cation Column
3720-V-02A/B	Strong Base Anion Column
3720-K-01	Decarbonator Blower
3720-Z-01	Decarbonator
3720-P-01A/B	Decarbonator Treated Water Pumps
3720-P-02A/B	BFW Makeup Pumps
3720-P-03A/B	Sulfuric Acid Transfer Pumps
3750-U-01A/B	Inert Gas Generation System
3750-U-02A/B	Inert Gas Generation System
3750-U-03A/B	Inert Gas Generation System
3760-V-01	Wet Air Receiver
3760-V-02	Air Surge Drum
3760-K-01A/B/C	Instrument/Plant Air Compressor
3760-U-02A/B	Air Dryer Package
3780-T-01	Potable Water Tank
3780-P-01A/B	HF Potable Water Pump
3780-P-02A/B	LF Potable Water Pump
3780-U-01	Chlorinator Package

PAVING LEGEND

- ASPHALT PAVING AREA
- -G- GRAVEL ROAD
- -G- GRAVEL YARD AREA

Figure 3.8-1

Cathedral Bluffs Shale Oil Company
UTILITIES

PLOT PLAN
PROCESS UTILITIES

SCALE: NONE | DRAWING NUMBER: 3700-A-01M | 83 | 2

REVISIONS: TO REFLECT CASE 87A DESIGN

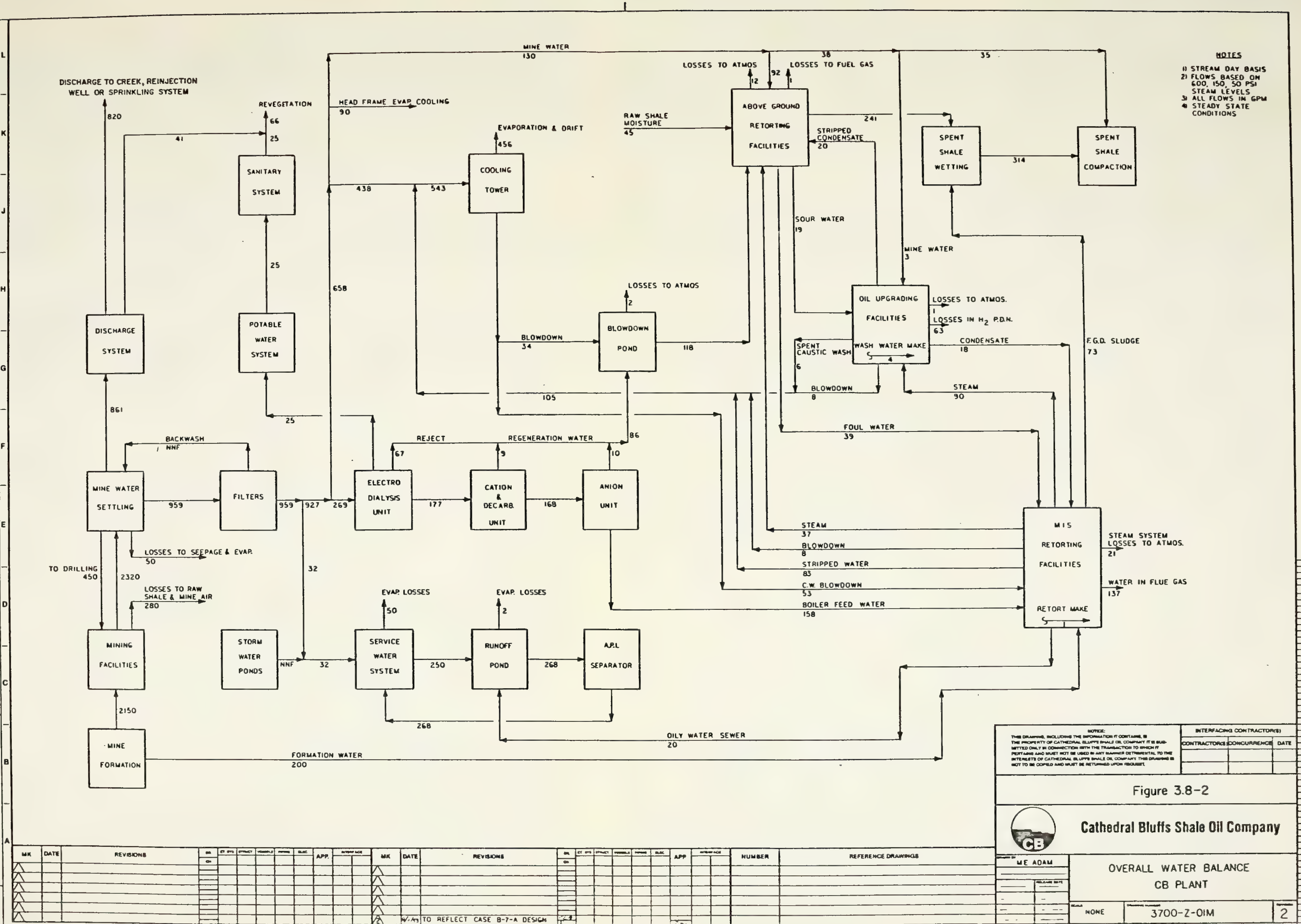

NOTES
1) STREAM DAY BASIS
2) FLOWS BASED ON 600, 150, 50 PSI STEAM LEVELS
3) ALL FLOWS IN GPM
4) STEADY STATE CONDITIONS
DISCHARGE TO CREEK, REINJECTION WELL OR SPRINKLING SYSTEM
820
41
REVEGETATION
66
25
HEAD FRAME EVAP. COOLING
90
MINE WATER
130
EVAPORATION & DRIFT
456
LOSSES TO ATMOS
12
92
LOSSES TO FUEL GAS
1
38
35
RAW SHALE MOISTURE
45
ABOVE GROUND RETORTING FACILITIES
241
STRIPPED CONDENSATE
20
SPENT SHALE WETTING
314
SPENT SHALE COMPACTION
SANITARY SYSTEM
438
543
COOLING TOWER
SOUR WATER
19
MINE WATER
3
658
LOSSES TO ATMOS
2
OIL UPGRADING FACILITIES
LOSSES TO ATMOS.
1
LOSSES IN H_2 P.D.N.
63
CONDENSATE
18
F.G.D. SLUDGE
73
DISCHARGE SYSTEM
POTABLE WATER SYSTEM
BLOWDOWN
34
BLOWDOWN POND
118
SPENT CAUSTIC WASH
6
WASH WATER MAKE
4
BLOWDOWN
8
STEAM
90
861
25
105
FOUL WATER
39
BACKWASH
NNF
REJECT
67
REGENERATION WATER
9
86
10
MINE WATER SETTLING
959
FILTERS
959
927
269
ELECTRO DIALYSIS UNIT
177
CATION & DECARB. UNIT
168
ANION UNIT
STEAM
37
BLOWDOWN
8
STRIPPED WATER
83
C.W. BLOWDOWN
53
BOILER FEED WATER
158
MIS RETORTING FACILITIES
RETORT MAKE
STEAM SYSTEM LOSSES TO ATMOS.
21
WATER IN FLUE GAS
137
LOSSES TO SEEPAGE & EVAP.
50
TO DRILLING
450
2320
32
LOSSES TO RAW SHALE & MINE AIR
280
EVAP. LOSSES
50
EVAP. LOSSES
2
MINING FACILITIES
STORM WATER PONDS
NNF
32
SERVICE WATER SYSTEM
250
RUNOFF POND
268
A.P.I. SEPARATOR
2150
268
OILY WATER SEWER
20
MINE FORMATION
FORMATION WATER
200
Cathedral Bluffs Shale Oil Company
OVERALL WATER BALANCE CB PLANT
M.E. ADAM
NONE
3700-Z-01M
2
TO REFLECT CASE B-7-A DESIGN
INTERFACING CONTRACTOR(S)
CONTRACTORS
CONCURRENCE
DATE
REVISIONS
REFERENCE DRAWINGS
NUMBER

Figure 3.8-2

3.8 Utilities and Off-site Facilities

CB currently holds a National Pollutant Discharge Elimination System (NPDES) permit and has been discharging excess mine water to Piceance Creek since 1979. Discharges of water will continue in compliance with the conditions of this permit.

3.8.3 Water Treatment System

Mine water, the primary source of water for the CB Project, needs various stages of treatment prior to its use as cooling water, potable water, boiler feed water, and so forth. The following is a description of these treatment facilities.

3.8.3.1 Mine Water System

The mine water system will include equipment for preliminary treatment of mine water prior to use in Materials Handling Facilities, AGR Facilities, OUG Facilities, MIS Facilities, and utility facilities. Excess mine water will be discharged to Piceance Creek from ponds A and B or pumped to Pond C for reinjection (see Figures 3.8-3 and 3.8-4).

Mine water from working areas will be pumped from the mine to existing Pond A where initial settling of solids and pH adjustment takes place. Pond A overflows to existing Pond B for final settling. Mine drill flush water is returned via pipeline from Pond B to the mine.

The mine water collected from the underground working areas will be kept separate from mine water which infiltrates into areas of low activity, such as shafts. The mine water from areas of low activity will be pumped to a clear water pond (Pond D) which will also serve as a fire water storage pond.

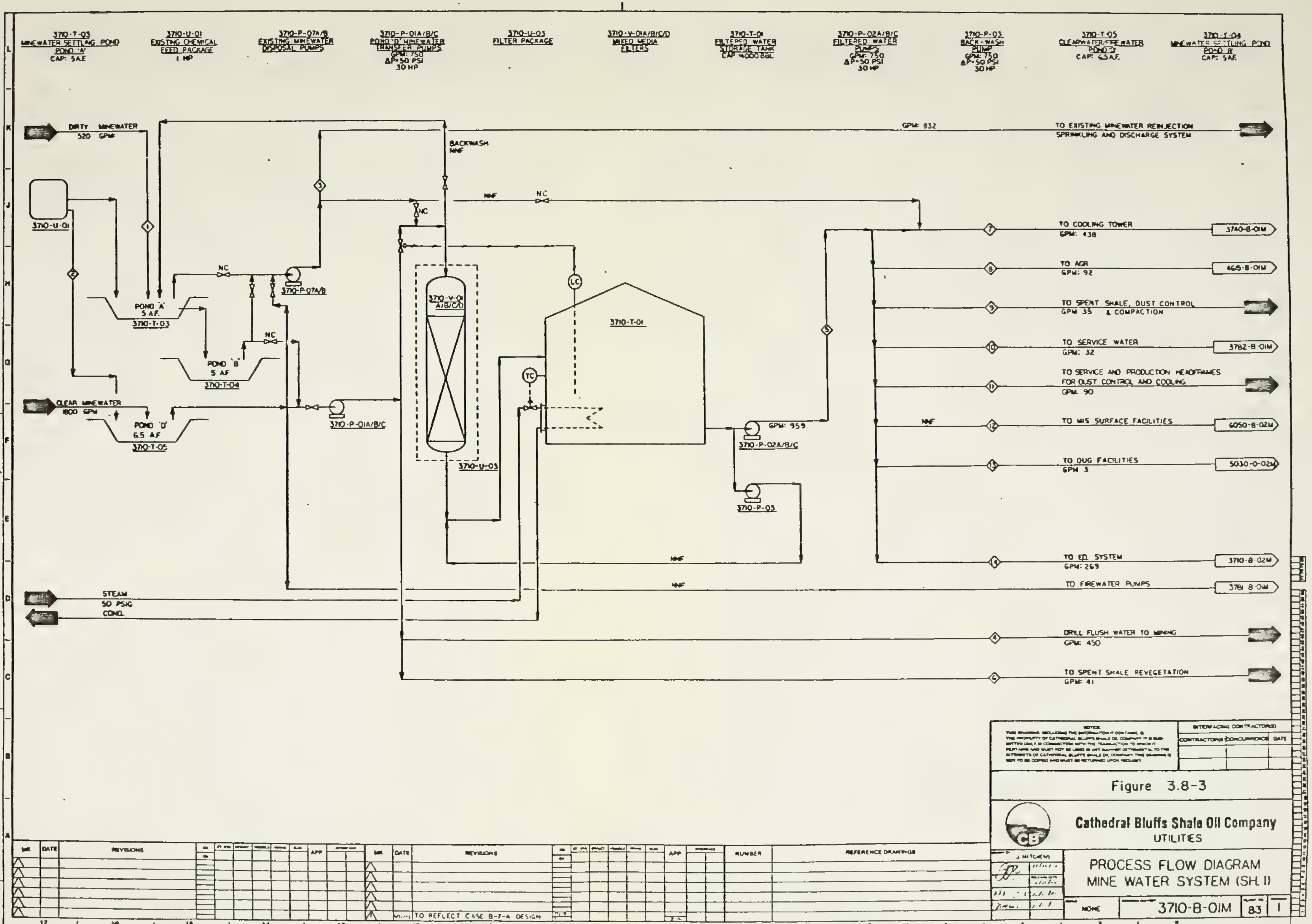
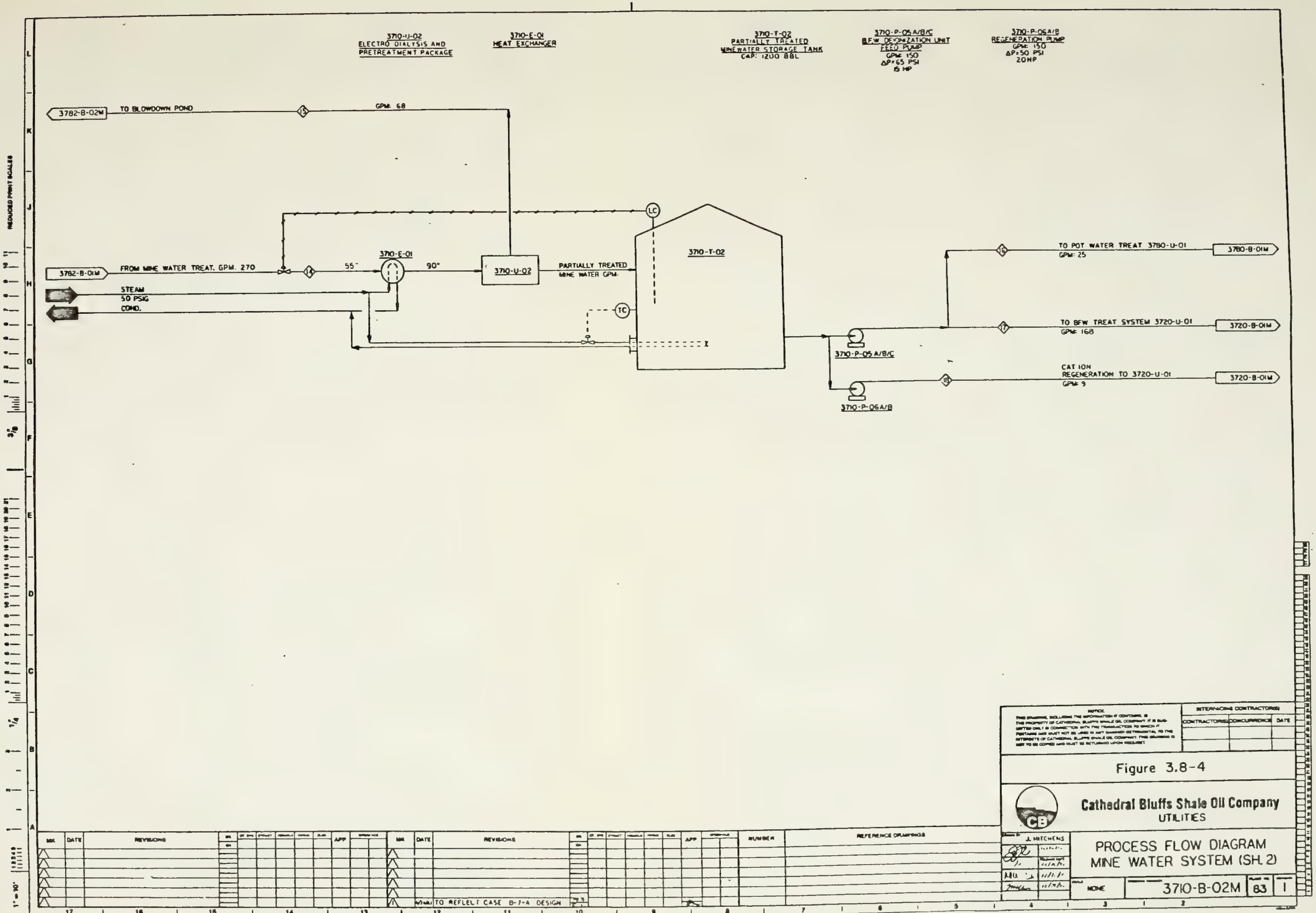


Figure 3.8-3

Cathedral Bluffs Shale Oil Company
UTILITIES

PROCESS FLOW DIAGRAM
MINE WATER SYSTEM (SH. I)

3710-B-01M



3710-U-02
ELECTRO DIALYSIS AND PRETREATMENT PACKAGE
3710-E-01
HEAT EXCHANGER
3710-T-02
PARTIALLY TREATED MINEWATER STORAGE TANK
CAP: 1200 BBL
3710-P-05 A/B/C
B.F.W. DEIONIZATION UNIT FEED PUMP
GPM: 150
ΔP=65 PSI
15 HP
3710-P-06A/B
REGENERATION PUMP
GPM: 150
ΔP=50 PSI
20 HP
3782-B-02M
TO BLOWDOWN POND
GPM: 68
3782-B-01M
FROM MINE WATER TREAT. GPM: 270
STEAM
50 PSIG
COND.
55°
90°
3710-E-01
3710-U-02
PARTIALLY TREATED MINE WATER GPM
LC
TC
3710-T-02
3710-P-05 A/B/C
3710-P-06A/B
TO POT WATER TREAT 3780-U-01
GPM: 25
3780-B-01M
TO BFW TREAT SYSTEM 3720-U-01
GPM: 168
3720-B-01M
CAT ION REGENERATION TO 3720-U-01
GPM: 9
3720-B-01M
TO REFLECT CASE B-7-A DESIGN
REVISIONS
REFERENCE DRAWINGS
Figure 3.8-4
Cathedral Bluffs Shale Oil Company
UTILITIES
PROCESS FLOW DIAGRAM
MINE WATER SYSTEM (SH. 2)
J. HITCHENS
NONE
3710-B-02M
83
1

3.8 Utilities and Off-site Facilities

This mine water destined for use as cooling water, process makeup water, potable water and boiler feed water will be pumped through mixed-media filters to remove any remaining suspended solids. It will then flow to a 4,000 Bbl storage tank to ensure a continuous flow of water to CB Plant users during upsets and surges.

A portion of the filtered water will be diverted to the cooling water treatment system, to the AGR and OUG as make-up process water, and to the MIS area for FGD sludge slurrying. The remainder will be pumped to the electrodialysis (ED) unit for partial demineralization. The ED unit will be preceded by a softening unit to lower the hardness of the water, thus avoiding scaling in the ED unit. The ED unit will operate with approximately a 25% rejection rate. The total dissolved solids of the mine water will be reduced from approximately 3500 ppm to 200-300 ppm. The rejected water will be piped to the blowdown pond for eventual use in processed shale wetting. The produced water from the ED unit will flow to a 1,200 Bbl storage tank which supplies the potable water and the boiler feed water treatment systems.

The mine water settling ponds have been in use since the start of the shaft sinking operation in 1979 and have operated satisfactorily. Filtration and electrodialysis treatment are well established technologies. A study comparing 1) partial demineralization by electrodialysis or reverse osmosis followed by full demineralization by ion exchange and 2) ion exchange only, showed electrodialysis to be less costly and better suited for removing the ions found in the mine water.

3.8.3.2 Boiler Feed Water Treatment

Partially treated boiler feed water (BFW) received from the ED unit in the mine water system will contain total dissolved solids (TDS) in the range of 200 to 300 ppm. The BFW system will be capable of reducing the TDS to below 3 ppm and the silica content to 0.3 ppm using ion exchange resins. Figure 3.8-5 shows the flow schematic for the BFW system.

The ED product water will first pass through a strong acid cation exchange column where cations such as calcium, magnesium, and sodium will be removed. Due to the production of carbon dioxide in the cation units, the water will pass through a decarbonator where the carbon dioxide will be stripped from the water with air before being fed into the strong base anion exchange unit. Anions such as sulfate, chloride, and silica will be removed in the anion unit. The treated water will then flow to a 10,000 Bbl BFW make-up storage tank. The BFW will be used in the AGR Sulfur Recovery Unit, the OUG Hydrogen Unit, and as make-up water for the low-BTU gas boilers in the MIS Surface Process Facilities.

Dual cation and anion exchange units will be used so that regeneration using sulfuric acid in the case of the cation unit and caustic soda in the case of the anion unit can take place. Regeneration and backwash waters will be sent to the blowdown pond and eventually used for retorted shale wetting and as plant service water.

3.8.3.3 Cooling Water Treatment

A circulation rate of 22,759 GPM of cooling water will be required by the various exchangers on site during normal operation. Figure 3.8-6 shows the flow scheme for the cooling water system. The make-up water for the system will be obtained from the filtered mine water supplemented by low-hardness boiler blowdown waters and stripped process condensate. Chemical analysis of CB mine

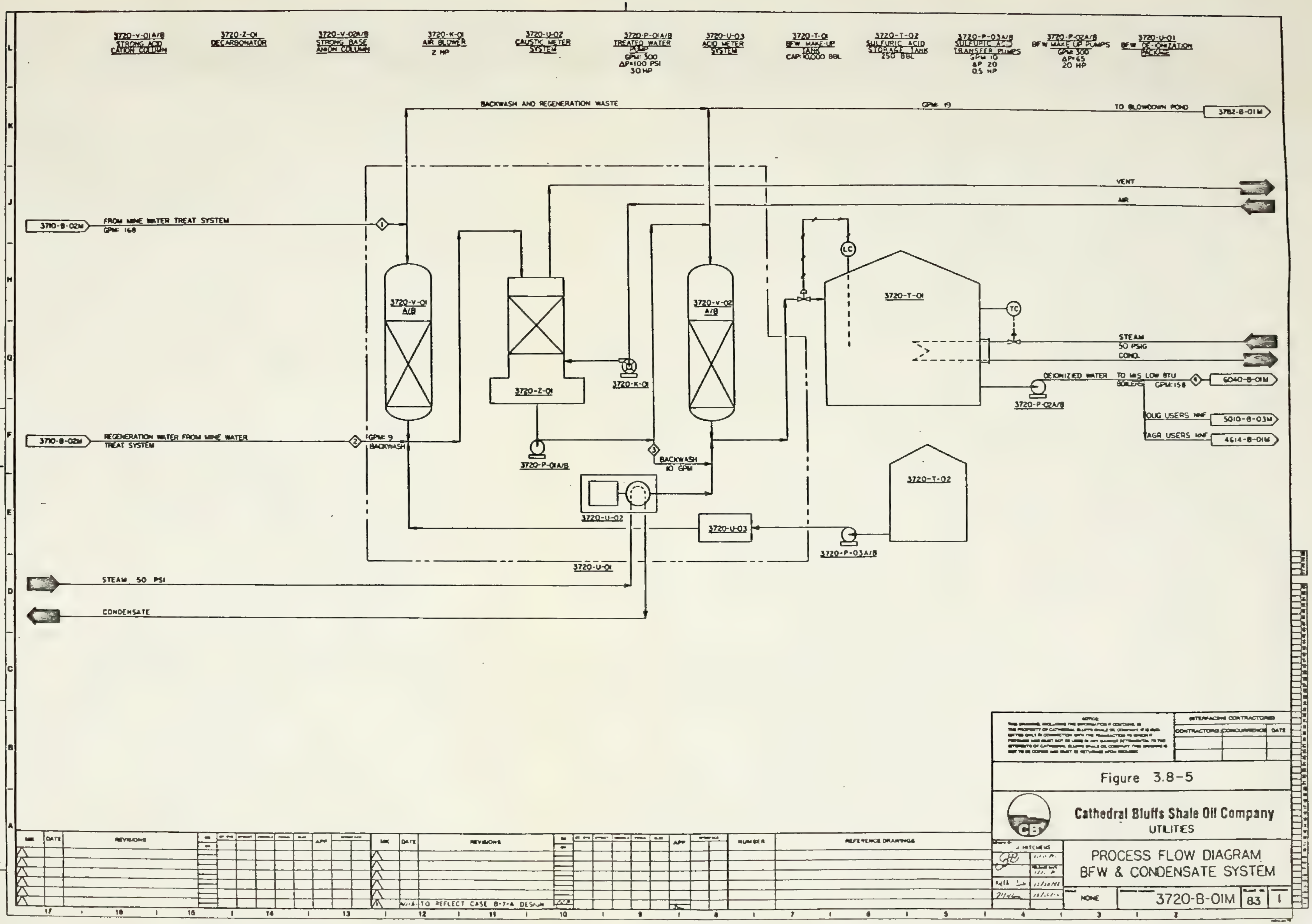

3720-V-01A/B STRONG ACID CATION COLUMN
3720-Z-01 DECARBONATOR
3720-V-02A/B STRONG BASE ANION COLUMN
3720-K-01 AIR BLOWER 2 HP
3720-U-02 CAUSTIC METER SYSTEM
3720-P-01A/B TREATED WATER PUMP GPM: 300 ΔP=100 PSI 30 HP
3720-U-03 ACID METER SYSTEM
3720-T-01 BFW MAKE-UP TANK CAP: 10,000 BBL
3720-T-02 SULFURIC ACID STORAGE TANK 250 BBL
3720-P-03A/B SULFURIC ACID TRANSFER PUMPS GPM 10 ΔP 20 0.5 HP
3720-P-02A/B BFW MAKE UP PUMPS GPM 300 ΔP=65 20 HP
3720-U-01 BFW DE-IONIZATION PACKAGE
BACKWASH AND REGENERATION WASTE
GPM: 19
TO BLOWDOWN POND
3782-B-01M
VENT
AIR
3710-B-02M
FROM MINE WATER TREAT SYSTEM
GPM: 168
3720-V-01 A/B
3720-V-02 A/B
3720-T-01
LC
TC
STEAM
50 PSIG
COND.
3720-Z-01
3720-K-01
DEIONIZED WATER
TO MIS LOW BTU BOILERS
GPM: 158
6040-B-01M
3720-P-02A/B
OUG USERS
5010-B-03M
AGR USERS
4614-B-01M
3710-B-02M
REGENERATION WATER FROM MINE WATER TREAT SYSTEM
GPM: 9
BACKWASH
3720-P-01A/B
BACKWASH
10 GPM
3720-T-02
3720-U-02
3720-U-03
3720-P-03A/B
3720-U-01
STEAM 50 PSI
CONDENSATE
Cathedral Bluffs Shale Oil Company
UTILITIES
PROCESS FLOW DIAGRAM
BFW & CONDENSATE SYSTEM
NONE
3720-B-01M
83
REVISIONS
REFERENCE DRAWINGS
TO REFLECT CASE B-7-A DESIGN

Figure 3.8-5

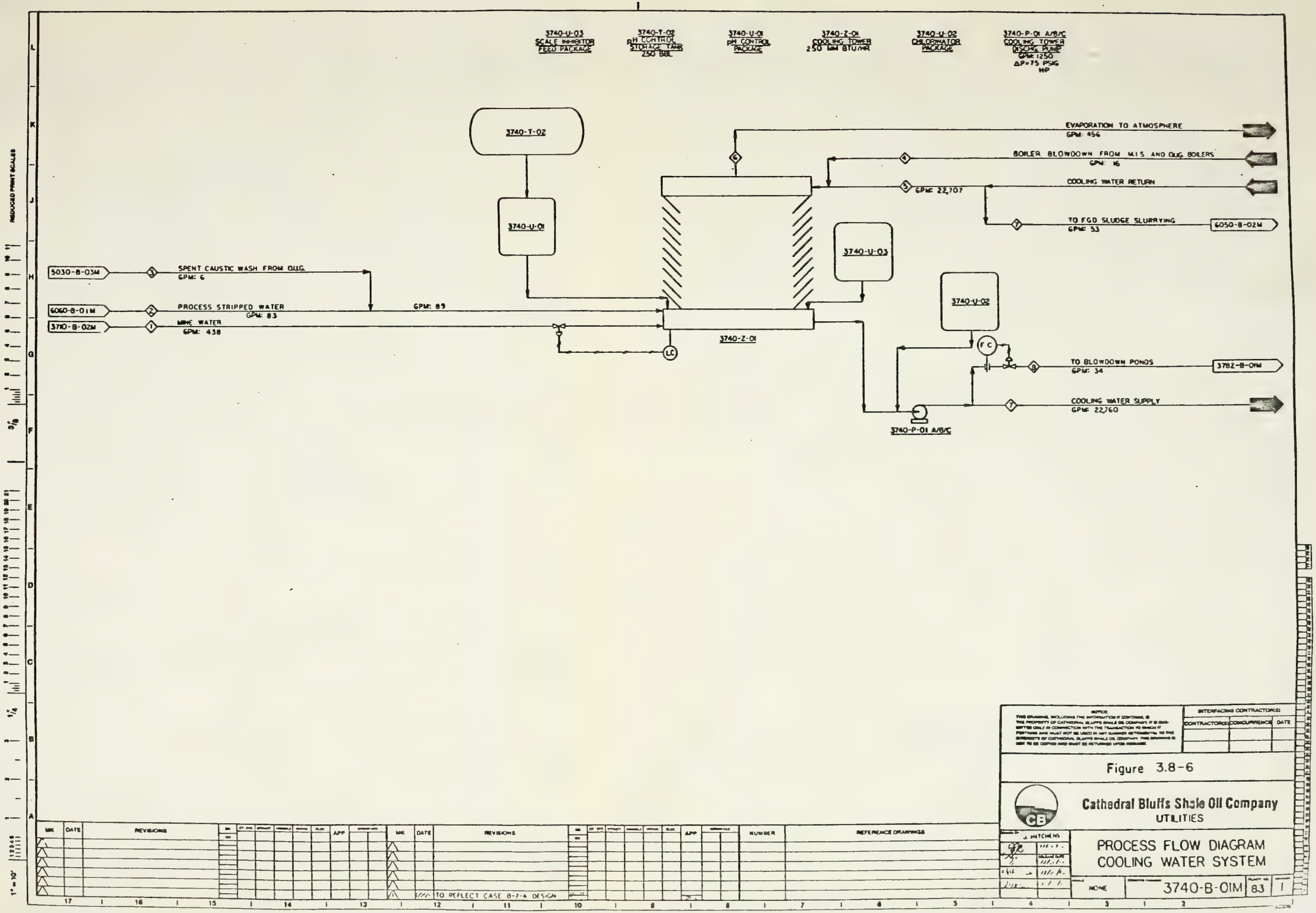


Figure 3.8-6

PROCESS FLOW DIAGRAM
COOLING WATER SYSTEM

water indicates that softening to reduce hardness and silica is not required. The cooling tower cycle concentration, however, will be controlled to ensure that the silica concentration in the circulating cooling water stays below 150 ppm and the TDS below 10,000 ppm.

A conventional redwood slat, induced draft cooling tower will be used. The tower will be designed to cool 25,000 GPM from 95°F to 75°F with a 65°F wet bulb temperature.

Sulfuric acid will be used to maintain pH of the cooling water at about 8.0. A corrosion/scale inhibitor will be added continuously. The blowdown will be sent to the blowdown pond and eventually used to wet retorted shale and for slurrying FGD sludge as described in Section 3.6.3. The cooling water will be provided to the battery limits of the MIS Surface Facilities at a pressure of no less than 60 psig.

3.8.4 Water Distribution

The water distribution system will be comprised of service water, potable water, cooling water and fire water. The demands for these services by various process units and other support facilities within the plant will be met by the following three central systems.

3.8.4.1 Service Water System

Service water will be drawn from the blowdown pond during normal operation. Other sources of service water will be storm water and mine water. A service water storage tank will ensure a constant supply to the service water pumps which maintain the supply header at 85 psig. Service water stations will be

distributed throughout the process areas and Mine Support Area. Service water will enter the mine through a borehole and be distributed by gravity. Following use, the service water will drain to collection sumps and will be handled by the oily water system.

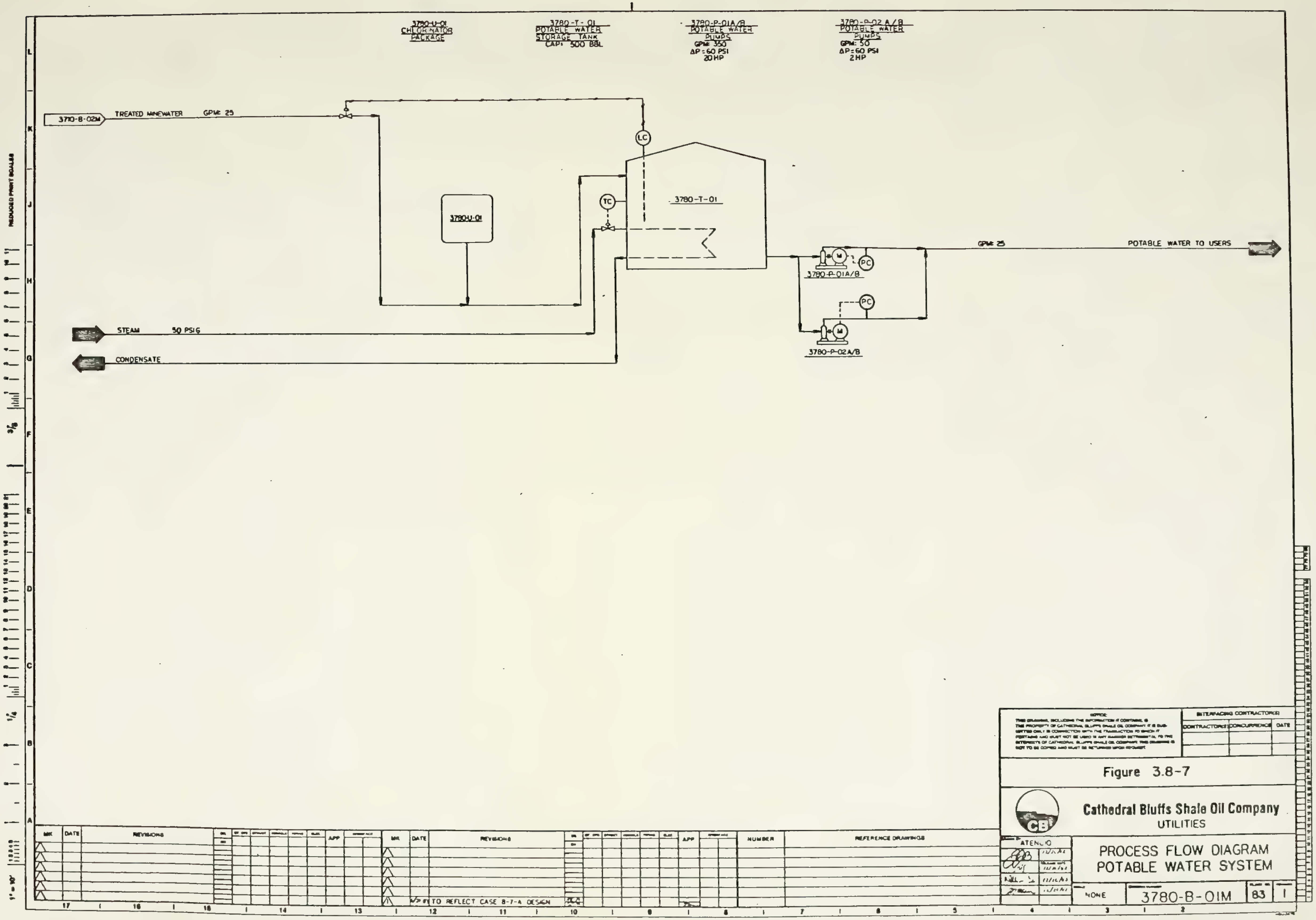
The blowdown pond will collect blowdown from the cooling tower, regeneration water from the boiler feed water ion exchange units and reject water from the mine water electrodialysis unit. Excess water will be used for cooling retorted shale.

3.8.4.2 Potable Water System

An average flow of 25 GPM of potable water will be required during normal operation. Figure 3.8-7 shows the flow schematic for the potable water system. The potable water will be produced from mine water that has been partially demineralized by the electrodialysis unit in the mine water system. Water from the electrodialysis unit will be chlorinated to provide a residual chlorine level of 3 ppm and stored in a 500 Bbl tank to provide surge capacity during periods of high demand. A dual pumping system will supply potable water to the supply header to meet both high and low demand conditions.

3.8.4.3 Fire Water System

The Fire Water System will supply fire water to the surface facilities as well as the Mine Support Area. The fire water will be drawn from a 6.5 acre-feet clear water pond that will be fed 65°F water from the mine. The capacity of the pond is significantly more than the 250,000 gallon fire water retention requirements for the mine. The pond can supply 150% of the required fire water rate of 5,000 GPM at 150 psi for four hours. There will be fire water loops around all major process plants and the tankage area. All loops will be 12 in. diameter, coated steel pipe. Lateral lines will extend from the water main into



3780-U-01
CHLORINATOR PACKAGE
3780-T-01
POTABLE WATER STORAGE TANK
CAP: 500 BBL
3780-P-01A/B
POTABLE WATER PUMPS
GPM: 350
ΔP = 60 PSI
20 HP
3780-P-02 A/B
POTABLE WATER PUMPS
GPM: 50
ΔP = 60 PSI
2 HP
3710-B-02M
TREATED MINEWATER
GPM: 25
LC
TC
3780-T-01
3780-U-01
GPM: 25
POTABLE WATER TO USERS
PC
PC
3780-P-01A/B
3780-P-02A/B
STEAM
50 PSIG
CONDENSATE
REVISIONS
REFERENCE DRAWINGS
NUMBER
TO REFLECT CASE B-7-A DESIGN
Cathedral Bluffs Shale Oil Company
UTILITIES
PROCESS FLOW DIAGRAM
POTABLE WATER SYSTEM
NONE
3780-B-01M
83
1

Figure 3.8-7

process areas to provide additional coverage. Fire water will be supplied to combination hydrant/monitors and conventional hydrants. The following equipment is provided as part of the fire water system:

Clear Water and Fire Water Pond (acre-feet) (Pond "D")	6.5
Fire Water Tank (Bbls)	63,000
Water Retained for Mine (gallons)	250,000
Fire Water Pumps	
2 - Electric Driven Units (GPM)	2,500 each
2 - Diesel Engine Driven Units (GPM)	2,500 each
1 - Jockey Pump (GPM @ 160 psig)	110

3.8.5 Sanitary Sewer System

Sewage from the Mine Support Area will be fed by gravity to a collection sump and then pumped to a 34,000 gallons per day (GPD) packaged biological treatment system. Sewage from the remaining process areas will flow by gravity directly to the treatment system.

Effluent water leaving the sewage treatment plant will be analyzed for Biological Oxygen Demand (BOD) and chlorinated to provide a residual chlorine between 1 and 3 ppm before being discharged.

The treatment unit selected has a proven design with a service history demonstrating compliance with regulatory guidelines. Both aeration lagoons and packaged treatment systems for sewage treatment were initially considered. The packaged unit was selected because it provides the same quality effluent as aeration lagoons and requires less plot area. This allows it to be located close to the CB Plant and the retorted shale dump where the effluent and sludge will be used for revegetation.

3.8.6 Oily/Storm Water System

The oily/storm water system is designed to handle process oil spills, service water from hose stations, and storm water that falls on areas which may have been exposed to process materials. Process and maintenance areas, where oil spillage is most likely, will be curbed and sloped to drain into oily water collection sewers. These sewers will flow into the runoff pond which in turn will feed an API separator. Oil removed in the API separator will be pumped to the off-grade shale oil tank for eventual return to the Aboveground Retorting Facilities where it will be reprocessed. The water effluent from the API separator will be used as service water as described in Section 3.8.4.1.

Storm water outside curbed areas will be collected by the storm water sewer system which feeds the storm water holding ponds. The storm water ponds are sized to receive a 100-year storm. There will be two storm water collection systems. One will connect the Mine Support Facilities, the Oil Upgrading Facilities, the Aboveground Retorting Facilities, and the utilities area and flow into a 6.5 acre-foot pond. The other collection system will flow from the MIS Retorting Surface Facilities to a 2.2 acre-foot collection pond. From there storm waters can be pumped to the 6.5 acre-foot collection pond for eventual disposal. The storm water system will be sized to handle the runoff expected during a fire water deluge in each main area. This situation would be more severe than the 100-year storm water flow under certain conditions.

The storm water will be used as service water in the service water system as described in Section 3.8.4. If it is contaminated with oil, it can be diverted to the API separator. Excess water that is free from contamination will be released to Piceance Creek. Two storm water ponds will be used so that initial storm water flow, which may be contaminated by oil, may be separated from subsequent uncontaminated storm water runoff.

3.8 Utilities and Off-site Facilities

3.8.7 Power Facilities

3.8.7.1 Natural Gas

A four-inch natural gas line to the Mine Development Area was installed by the Western Slope Gas Company in 1979 (see Figure 3.8-8). This line supplies natural gas to an electric generating plant consisting of four 1,000 kilowatt (kw) gas-engine-driven generators. The generator plant supplied the electrical power for shaft sinking, mine water pumping, and miscellaneous power and lighting requirements. The gas engine generator plant was converted to emergency service in 1982 when White River Electric Association extended power lines to the Tract.

Ultimately the natural gas system will feed the Hydrogen Unit of the OUG Facilities and provide pilot gas to all the process furnaces and flares.

3.8.7.2 Electricity

The CB Plant and Mine will require approximately 37.5 megawatts (mw) of electric power when operating at rated capacity (see Table 3.8-1). This power will be supplied by the White River Electric Association of Meeker, Colorado. The single pole line supplying this electrical power is 20 miles long and is rated 138,000 volts (138 KV) and 100 megavolt amperes (mva) capacity (see Figure 3.8-9). This line has been installed and is in service.

The power line enters the site at a 138 kv switchyard owned by the White River Electric Association on the northern boundary of the Tract. This switchyard was installed to allow a second source of electrical power to be connected to the site. The second power line would probably be installed in the same right of way if required by future expansion of the Project.

C-b SHALE OIL PROJECT

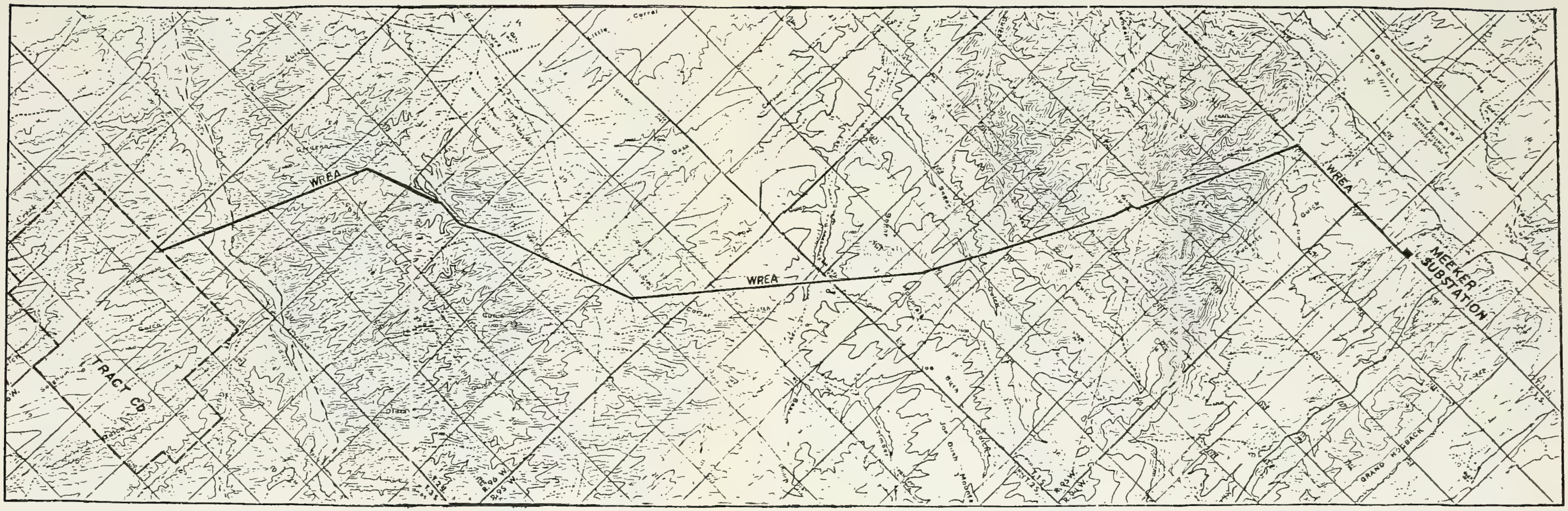
EXISTING LINE
EXISTING CB ROW & LINE

FIGURE 3.8-8
Natural Gas Pipeline ROW

TABLE 3.8-1

Breakdown of Electric Power Demand

	Kilowatts
Oil Upgrading Facilities	6,000
Aboveground Retorting Facilities	7,080
Materials Handling Facilities	2,646
Off-sites/Utilities	1,404
Mine Support Area	13,571
MIS Facilities	6,802
TOTAL	37,503



WREA TRANSMISSION LINE 138 Kv

OIL SHALE TRACT C-b

FIGURE 3.8-9
POWERLINE RIGHT-OF-WAY

3.8 Utilities and Off-site Facilities

From the switchyard, the 138 kv pole line travels approximately one mile to the existing mine substation. The mine substation, completed in 1982, was originally designed for only the mine portion of the Project. It will be expanded to supply power to the mine, the CB Plant Facilities, and the MIS Process Facilities. This will require the addition of a transformer and additional switchgear. With the addition of a second transformer, the substation will be of the secondary selective type. This will allow operation of the entire facility on one transformer, if the other transformer or its associated switchgear fails.

The incoming 138 kv power is stepped down to 13.8 kv at the mine substation. One side of the switchgear lineup in this substation will serve the mine and part of the MIS Process Facilities. The other side will serve the remaining portion of the surface plant and one mine underground feeder and one mine vent fan. This will provide redundancy for critical functions in case of system failures. All breakers and protective relays in the substation will be capable of remote operation and monitoring from the main control room.

The emergency generator system will consist of seven 1,000 kilovolt ampere natural-gas-burning, spark-fired, engine-driven generators. Four of these generators are presently installed and three more will be installed in the existing building. They will supply emergency power for one ventilation fan, dewatering pumps, and the cage hoist in the mine. The above ground processing facilities will require emergency power used primarily in the AGR Facility and the Hydrogen and Hydrotreating Units of the OUG Facility. The MIS Process Facilities will require emergency power mainly for the Offgas Compression System.

3.8.8 Steam Generation System

Steam requirements will be met by steam provided by the low-BTU gas boilers in the MIS Surface Process Facilities area as described in Section 3.6. Steam distribution is to the Oil Upgrading Facilities, Abovegound Retorting Facilities and utility area.

3.8 Utilities and Off-site Facilities

The hot and cold condensate recovered in the AGR, OUG, and utilities areas will be returned to the deaerator in the Hydrogen Unit. The demineralized water along with some excess cold condensate will be sent to the Steam Generation Facilities in the MIS Process Facilities as BFW make-up water.

3.8.9 Inert Gas Generation System

An Inert Gas Generation System will supply inert gas on a continuous basis to the AGR Facilities. The system will consist of two packaged units, each with a capacity of 15,000 SCFH.

Purging of the retort by inert gas will be accomplished over a period dependent on the availability and capacity of the joint inert gas generator packages. Each of the two inert gas packages can be turned down to one-fifth of its design flow rate without affecting inert gas composition.

3.8.10 Fuel Gas System

The Fuel Gas System for the CB Plant will be comprised of two independent fuel gas systems, one supplying natural gas and the other internally generated plant fuel gas. The natural gas system will primarily supply the the Hydrogen Unit in the OUG Facilities and will also supply pilot gas to all the process furnaces and flares. The Fuel Gas System supplies fuel for all of the process and utility users.

The sweet AGR fuel gas from the AGR Sulfur Recovery Unit and sweet hydrotreater offgas from the Hydrotreating Unit in the OUG Facilities will be mixed in the fuel gas blend drum. The Fuel Gas System will be supplemented by natural gas using pressure control to meet the Plant fuel gas demand. The fuel gas blend drum will supply fuel to the AGR, OUG, Materials Handling, Utility Facilities, and MIS Process Facilities. During normal operating conditions

natural gas will not flow to the fuel gas blend drum. The Fuel Gas generated in the AGR and OUG Facilities will be sufficient to meet the process demand. The excess fuel gas will be sent to the MIS Process Facilities to be used as supplemental fuel in the low-BTU boilers.

The natural gas system will consist of a knockout drum and a distribution header to provide feed to the Hydrogen Unit, the process furnaces and the flare pilots. The mine air heating facilities, the Mine Support Area heating facilities, and the MIS Process Facilities will be served by the plant natural gas supply header. The net natural gas demand during commercial operation will be 9.7 MMSCFD.

3.8.11 Instrument and Plant Air System

A single air compression/drying system will furnish, from a central facility, both instrument and plant air to the MIS Surface Processing, Aboveground Retorting, Materials Handling, utilities, and Oil Upgrading Facilities.

A second air equipment package will supply air to the Mine Support Area including the maintenance shop and Production and Service Shaft Headframes.

3.8.12 Flare System

The Flare System will handle operational as well as emergency flaring of hydrocarbon liquids, hazardous vapors, and hydrocarbon vapors and gases. It will dispose of liquid-free vapors or gases to the atmosphere by safely burning these products in a flare stack. Each process unit will be equipped with flare headers to collect gases from operational vents, emergency vents, and relief valves. A single low pressure header will serve the AGR Facilities, OUG

3.8 Utilities and Off-site Facilities

Facilities and utilities and will receive discharges from the relief valves set at relatively low pressures. A separate high pressure flare header in the Hydrotreating Unit and the Hydrogen Unit of the OUG Facilities will collect discharges from the relief valves set at relatively low pressures. A single 12 in. flare line from the sponge oil splitter in the MIS Process Facilities will connect to the lower pressure flare header.

A single flare knockout drum will separate any liquids that have condensed in the flare line. Liquid collected in the drum will be pumped back to the off-grade shale oil tank located in the tank farm. The flare stack will be equipped with a gas seal to ensure flashback protection. The safe purging gas requirements for the gas seal will be attained by continuously purging all process unit flare headers with refinery fuel gas. Steam will be supplied to the flare stack for smokeless operation and will be controlled by measuring the flow of the flared products.

The stack diameter has been designed to maintain the vapor velocity at well below 50% of the sonic velocity under maximum relieving conditions. The stack height is dictated by limiting both ground level gas concentrations and the maximum radiation including the solar radiation at the base of the stack to 1500 BTU/hr-ft^2.

3.8.13 Interconnecting Pipeways

This category includes all interconnecting pipes whether buried or in pipe racks. All piping will be on pipe racks with the exception of the fire water system, sanitary sewer piping and the storm water collection system. Outside the process area, lines carrying potable water, natural gas and mine water will leave the pipe rack in the northwest corner of the Oil Upgrading Facility and go underground into the Mine Support Area.

3.8 Utilities and Off-site Facilities

3.8.14 Mobile Equipment

Table 3.8-2 is a list of mobile equipment required to support the CB Plant including the Mine Support Area and the Raw and Processed Shale Handling Facilities and to support process operations and maintenance, mine maintenance, safety, and administration.

3.8.15 Buildings

The estimated size and type of buildings to be located on-Tract appear in Table 3.8-3.

3.8.16 Transportation System

The main access road to the Tract was constructed in 1978 (see Figure 3.8-10). The road miles to destinations in the vicinity are as follows: Rifle and Interstate 70, 41 miles southeast; Rangely, 60 miles northwest; and Meeker 46 miles northeast. Transportation routes and current traffic loads, projected transportation impacts of the project, and mitigation measures are discussed in Section 7.0 On-Tract, paved roads will be provided to and around the parking lots and around the headframes and shop/warehouse area. The main road to the parking area is 34 ft. wide. The other roads are 22 ft. in width. The roads have a four inch gravel base and four inches of asphalt. Gravel service roads will also be provided. These will be 22 ft. wide with a 9 in. gravel base coarse-topped with 3 in. of gravel.

Parking lots will be built to the south of the Changehouse/Operations Building. Parking spaces for 275 vehicles are in place, and clear areas are planned for an expanded parking area. Parking lots are covered with four inches of gravel base coarse-topped with four inches of asphalt.

TABLE 3.8-2

Mobile Equipment

Item	Quantity
Mine Support Area	
Mowers	6
Pickup Trucks	8
Pickup Trucks with Plows	2
A-Frame Truck	2
Tool/Welding Truck	1
Station Wagon	2
Stake Truck	2
Dozer (D7)	1
Grader CAT 14G	1
Surface Facilities	
Bottom Dump Trailer	1
Lowboy with Tractor 50T	1
Forklift 2T	3
Front End Loader	1
Dump Truck 85T	2
Dump Truck 70T	2
Dozer D8L	1
Dozer D7G	1
Compactor (CAT 825C)	2
Grader (CAT 14G)	1
Fuel & Lube Truck	1
Water Truck	1
Pickup 1T	7
Pickup 1/2T	16
Backhoe with Front End Loader	2
Mobile Crane	1
Tire Changer Lift Truck	1
Cherry Picker 5T	1
Tank Truck 10,000 Gallon	1
Portable Air Compressor	2
Portable Welding Machine	4
Flat Bed Truck 5T	1
Ambulance	1
Fire Truck	2

TABLE 3.8-3

ON-TRACT BUILDINGS

	Size square feet
Changehouse/Operations Building	80,000
Maintenance Shop and Warehouse	75,600
ANFO Silo/Handling Building	700
Blast Cap Storage Building	500
Dynamite Storage Building	700
Secondary Screening & Crushing Building	8,400
Transfer & Sampling House	3,465
Final Screening & Fine Ore Building	30,600
Truck Loadout and Transfer Building	7,680
Spent Shale Wetting Building	9,600
Laboratory Building	3,300
Boiler House	33,600
Control Building - Main	7,700
Control Building - MIS	2,600
Compressor Building	4,200
Area Maintenance	7,000
Miscellaneous Shelters	37,340
Pump Sheds	1,800
Fire Water Pump Station	1,500
FGD Regeneration Buildings	10,200
Instrument Air Compressor Building	1,800
Fire Station - 3 Bay	2,250
Field Toilets (3)	750
Water Treatment Building	1,800
Guard Houses (2)	300
Open-sided Storage Shed	5,000
Centrifuge Building	1,800
Mine Air Vent Heating Facility	N/A
Emergency Generator Building - MIS	800
Boiler Chemical Feed Building - MIS	800
Offgas Vent Blower Building - MIS	1,000
Recreational Vehicle Site Acreage (350 lots) - Mancamp	37 acres
Bathhouse (2) - Mancamp	2,500
Laundry - Mancamp	840
Maintenance Building - Mancamp	2,025
Security Building - Mancamp	840

KEY

——— PAVED

- - - - - UNPAVED

FIGURE 3.8-10
Roadway ROW

3.8 Utilities and Off-site Facilities

3.8.17 Product Storage Facilities

The Product Storage Facilities will consist of storage facilities for raw shale oil, syncrude product, diesel fuel, ammonia, sulfur (including vapor recovery); truck loading and unloading facilities; and pipeline transfer pumps. The facilities are shown on Process Utilities Plot Plan, Figure 3.8-1. The sulfur storage, loading and unloading facilities will be located within the OUG Sulfur Recovery Unit within the Oil Upgrading Facilities.

The Product Storage Facilities will include the following tanks:

	Number	Total Capacity
Raw Shale Oil Tankage	2	100,000 Bbl
Syncrude Oil Tankage	2	100,000 Bbl
Diesel Storage Tank	1	3,600 Bbl
Sulfur Storage Tank	1	700 Bbl
Ammonia Storage	3	90,000 Gallons
Off-grade Shale Oil	1	12,000 Bbl

Raw shale oil product from the AGR will be pumped to the raw shale oil storage tanks. The storage tanks will have a total capacity of 100,000 barrels which is approximately 7 days storage for the Shale Oil Upgrading Facilities. The tanks will be equipped with cone roofs with floating roofs (or equivalent) and internal bayonet steam heaters.

Raw shale oil transfer pumps will feed shale oil to the oil upgrader (OUG). There will be provisions for transfering the raw shale oil to the truck loading rack should the need arise because of pipeline or pump failure.

3.8 Utilities and Off-site Facilities

Syncrude product from the OUG Facility will be pumped to the syncrude storage tanks. These tanks will also have a total capacity of 100,000 Bbls. Syncrude booster pumps will transfer syncrude from tankage to the main pipeline pump station. Facilities will be provided for transporting the syncrude by trucks should the need arise.

Diesel fuel will be received by truck and stored in a 3600 Bbl tank which will be heated during winter. Diesel pumps are provided to supply fuel to the mine and surface mobile equipment. The storage tank will meet requirements for approximately 30 days at peak levels of use.

A common truck loading/unloading rack will handle raw shale oil, syncrude and diesel fuel. The rack will be equipped with metering, loading arms, lighting and an operator shelter.

The ammonia product from the ammonia recovery unit will be stored in pressurized bullets. These vessels will accommodate four days production of the ammonia product.

Oil removed in the API separator in the oily/storm water system will be pumped to the off-grade shale oil tank for eventual return to the AGR Facilities where it will be reprocessed.

3.8.18 Product Transporation

3.8.18.1 Pipeline

The syncrude pipeline to Rangely, Colorado will be designed to transport up to 14,100 barrels per calendar day (BPCD) of hydrotreated shale oil. This system could be expanded to about 25,000 BPSD with the addition of booster pumps at the pump station.

3.8 Utilities and Off-site Facilities

The pipeline will originate at a pump station located on the C-b Tract immediately adjacent to the syncrude product tankage. The pipeline system will be a typical buried pipeline with intermediate isolation valves and pump stations.

The precise route of the pipeline has not been established and will be developed in cooperation with the County Corridor Committee and BLM. Alternatives under consideration are shown on Figure 3.8-11 and include:

1) CB Alternate Route I--Northeast along the ridge to the west of Cottonwood Gulch to Piceance Creek where it joins with the existing BLM multi-use corridor. This is the LaSal route to Casper or Rangely to the north or Fruita and Moab to the South.

2) CB Alternate Route II--South-southwest from the Tract, joining the BLM corridor presently used by Rocky Mountain Gas. To the south the route could join either the Union or LaSal routes.

3) CB Alternate Route III---Northwest along Scandard Gulch, then north along Willow Creek to Piceance Creek and northwest along Piceance Creek. This route proceeds to Rangely, Colorado.

Alternative routes will connect to existing pipeline corridors.

3.8.18.2 Pump Station and Terminals

A single pump station will be installed at the CB Plant site. The pumping system will consist of two electric motor driven multi-stage centrigual pumps: one operating and the other serving as a spare.

The station will be unmanned and remotely controlled from the plant control room. The station will also include a manual launcher for a scraper/pigging operation and a sump tank for blowdown liquids.

BLM CORRIDOR; EXISTING ROCKY MT. GAS LINE
BLM MULTI-USE CORRIDOR
CB ALTERNATE ROUTE 1
CB ALTERNATE ROUTE 2
CB ALTERNATE ROUTE 3

FIGURE 3.8-11
ALTERNATIVE ROUTES
FOR SYNCRUDE PIPELINE

3.8 Utilities and Off-site Facilities

3.8.19 Rifle Marshalling Yard

A marshalling yard will be established on property owned by CB approximately 4 miles west of Rifle along Interstate 70. Rifle is located approximately 40 road miles from the C-b Tract and is the nearest town with rail service.

The purpose of the marshalling yard is to receive and offload construction materials and equipment shipped via rail, store them temporarily when required, and load them on trucks for final shipment to the C-b Tract. Later, the staging area will function as a receiving terminal for cement, limestone, ammonium nitrate and operating supplies shipped by rail. The Rifle by-pass will be utilized wherever practicable for all truck movement.

Facilities on the property will include a laydown area, rail spur with dock facilities and work areas for doing construction work on equipment before it is forwarded to the site. A rail spur from the existing Denver and Rio Grande Western Railway main line will be laid to the staging facility. This spur will disturb approximately five to ten acres. Site improvements for the marshalling yard will be minimal and include perimeter fencing, area paving, and area lighting. Yard development is scheduled for 1985.

3.8.20 Byproduct Transportation

As discussed in Section 3.7, approximately 46 tons per day of high quality fertilizer-grade anhydrous ammonia and 36 tons per day of sulfur will be recovered from the AGR and OUG Facilities. These byproducts will be stored on-site and transported from the site by the purchaser. It is anticipated that the buyer will transport the byproducts in tank trucks to Rifle where they will be transferred to rail cars.

3.8 Utilities and Off-site Facilities

3.8.21 On-site Housing Facility (Mancamp)

3.8.21.1 Description of On-site Housing

In order to meet the projected short-term housing demand of the temporary construction workforce, CB plans to develop a single-status housing facility (mancamp).

Figure 3.2-2 illustrates the planned mancamp location within the CB Project site. Approximately 40 acres have been identified to accommodate the facility, which will be designed for up to 850 units. The facility will be a full-service operation, consisting of a combination recreational vehicle (RV) park/mobile motel-type facility of up to 350 units, and a modular housing development containing up to 500 motel-style or bachelor quarter (BQ) units. The design of the facility will allow the construction of the 850 units/spaces in two development stages. Construction of up to 350 RV spaces and mobile motel-type units on RV sites will proceed initially followed by up to 500 motel-style units. The design of the mancamp will be flexible in order for CB to build either the full component of RV spaces or a combination of RV spaces (e.g., 200) and mobile motel-style living quarters (e.g., 150). A conceptual site plan for the 850-unit mancamp depicting residential building locations, traffic circulation, security facilities, dining hall/administration building (Community Center), recreational facilities, and ancillary mancamp facilities is shown on Figure 7.4-1a. A typical living unit floor plan and individual RV space layout are illustrated in Figure 7.4-1b.

The 350 RV spaces will require approximately 20 acres. The spaces will be nominally 25 feet by 50 feet, or 25 feet by 60 feet, with each space designed to accommodate one RV trailer. Electrical, culinary water, and sanitary sewer services will be available to all spaces. Street design will promote orderly and safe vehicular and pedestrian circulation. Buses will be allowed to travel only

on collector streets, which will be wider than the local streets. Two bath houses will be strategically located within the RV park. Each will provide showers and toilet facilities (men and women) and laundry facilities for approximately 175 occupants. The mobile motel-style units will contain showers and lavatories within the units.

The 500 modular, motel-style units and related ancillary facilities will require approximately 20 acres. The single-status motel-style units will be incorporated in two-story buildings. The conceptual design envisions each building containing 28 rooms, designed for one person occupancy. Current plans depict the motel-style rooms containing approximately 210 square feet of living space, with a private lavatory and shower. Typical furnishings include: closet space, bed, reading light, dresser, desk, and chair. There will be laundry facilities, a small lounge, and storage area within each 28-room building. Maid services will be available.

There will be a nominal fee charged to both motel unit and RV park occupants. The exact amount of the fee remains to be determined based upon economic conditions existent at the time of occupancy of the units.

3.8.21.2 Support Facilities

In order to attract and retain a construction worker in the single-status facility for the longest possible duration, special amenities and features will be developed. Special emphasis will be given to the development of an appealing living environment, with priority given to the living quarters, dining area, indoor recreation facilities, and outdoor amenities. In addition, the single-status facility will include the following ancillary services: fire protection, medical, security protection, laundry, postal services, and a commissary. Full culinary water and wastewater treatment systems will be incorporated.

3.8 Utilities and Off-site Facilities

Construction specifications will provide for paved streets, open space, limited lawn and landscape amenities, and a general exterior decor which will contribute to a pleasing appearance. Bus stops will be established at key access points to accommodate busing of workers to and from the plant site and to provide for routine trips to surrounding communities.

The design and construction of all mancamp infrastructure will comply with pertinent state and local regulations. The culinary water system will be designed to provide up to 55 gallons per person per day for each RV occupant and 75 gallons per person per day for each motel-style unit occupant. To ensure adequate fire protection, design requirements will be based upon a recommended minimum flow of 1,000 gallons per minute for a two-hour duration. A water sprinkler system will be constructed in the dining hall facility to gain the necessary fire protection.

An adequate supply of culinary water will be provided by a domestic water treatment facility located at the Project site. This water will be stored in facilities with a capacity equal to the average daily flow, plus fire flow. Adequate pumping facilities will be provided as needed to maintain storage and design pressures and fire flows. The entire culinary water system capacity will conform to Colorado Health Department standards.

It is expected wastewater volume will be equal to domestic water supply less any irrigation flow from the system. Similar to the culinary water system, the design and construction of the wastewater collection system will conform to Colorado Health Department standards.

A single entrance into the mancamp will be necessary to manage traffic movement and for security purposes. Two types of streets will be designed to move vehicles within the mancamp. First, 36-feet wide collector streets will serve as the major carriers for through traffic and internal circulation of trucks, buses, and maintenance vehicles. Second, a 24- and 30-feet wide local

streets will serve one primary function--moving workers to their respective dwelling units from the collector streets. Both the collector and local streets will be paved, but without curb and gutter. Sidewalks will be constructed among the motel-style units to promote efficient pedestrian movement to and from recreational and dining facilities. It is not expected sidewalks will be constructed within the RV park.

Parking will be provided for a percentage of the mancamp residents. Parking will also be provided for auxiliary uses; i.e., visitor parking, security, maintenance, and administration. Bus stops will be strategically located throughout the facility to provide convenient service to all occupants.

The design and construction of the mancamp will include storm drainage and retention facilities to control surface runoff. It is expected that the majority of the runoff will be carried above ground in the streets, back lot lines, and open ditches. To prevent soil erosion, the Project will landscape and revegetate all disturbed property. As a security measure, the entire mancamp perimeter will be fenced with a six-feet high chain link barrier. Both electrical and natural gas facilities are currently available within the Project site. Cathedral Bluffs will work with the appropriate utility companies to ensure that adequate power and gas are available in a timely manner for construction and operations of the mancamp.

3.8.21.3 Services

Cathedral Bluffs will develop a dining facility to accommodate from 500 to 600 workers. It is expected that this facility will primarily serve the motel unit occupants, but it will be available to the RV park residents. The facility will provide three meals per day, Monday through Friday. It is expected that limited dining services will be needed for the mancamp population on the weekends. Should the Project go to a six or seven day work week, full dining services will be available on those days. A commissary will operate in the

dining hall and include the following services: post office, barbershop, vending machines, magazine shop, non-prescription drugs, and toiletries.

Cathedral Bluffs intends to provide shuttle transportation services within the mancamp. As mentioned, bus stops will be conveniently located throughout the motel area and RV park, with adequate loading and unloading area. The bus stops will be signed and bus schedules made available to all mancamp residences. Shuttle buses will transport workers to and from the plant site, a one-way distance of approximately one mile. Adequate buses will be available to ensure that the mancamp residents can be transported in a timely manner. Shuttle service to Rifle and Meeker will be available daily to all mancamp occupants.

Both indoor and outdoor recreational facilities will be available to all mancamp occupants. It is expected the indoor facilities will be incorporated in the dining hall building, in conjunction with the administration facilities to ensure proper management of indoor equipment. Indoor facilities planned for the mancamp include: pool tables, ping-pong, foosball tables, TV room, card tables, electronic games, and reading room. Outdoor recreational amenities will be constructed, including: basketball courts, volleyball courts, horseshoe pits and a softball diamond.

Cathedral Bluffs will coordinate its security programs with local law enforcement agencies. Cathedral Bluffs will initiate a security program, which includes fencing the mancamp site primarily to discourage trespassing. The site's perimeter and housing developments will be patrolled regularly by security officers equipped with radio transmitters. To control vehicular and pedestrian movement into the site, a guard station will be constructed at the entrance to the mancamp area. This station will be manned on a 24-hour basis by uniformed security personnel. The RV park area, motel units, parking lots, administration buildings, and entrance guard station will be well lighted to minimize damage to property and persons.

3.8 Utilities and Off-site Facilities

The following fire protection services will be provided. First, a pumper truck will be housed at the mancamp in an indoor building. This vehicle will be equipped with the required auxiliary facilities, i.e., fire hoses, foam, axes, and extinguishers. The major mancamp building (dining hall/administration/indoor recreation facility) will be fitted with a water sprinkler system. This facility and the living unit buildings will be equipped with smoke alarms in each room. Fire extinguishers and fire hoses will be strategically placed in each residential building and the dining hall. Security personnel on 24-hour duty within the mancamp compound will be trained to assist the designated fire protection personnel in any emergency situation. Mancamp residents will be informed on typical fire safety and evacuation methods.

Cathedral Bluffs will provide medical support services at the mancamp. A fully equipped ambulance will be housed on the Project site available to personnel at the plant site and mancamp. A first aid station will be located in the security building and staffed with certified emergency medical technicians. The Project will coordinate the delivery of medical services with the Meeker and Rifle hospitals.

A maintenance building will be constructed on the Project site to provide storage and a workshop for maintenance equipment and supplies. It is expected the utility maintenance, ambulance, fire protection and security vehicles will be housed in this building.

3.0 PROJECT DESCRIPTION

3.9 Project Development Plan

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3.9 Project Development Plan

3.9.1 Project Plan

Consistent with the CB/SFC term sheet, the plan for development of the CB Lease Tract is based on a single Unishale-B AGR supplied by shale produced from both room and pillar and MIS mining, and from oil extracted during the processing of the MIS retorts. The non-subsiding mine plan is based on a 40 foot Room and Pillar Mine and 278 foot MIS retorts, four in primary production at once. Under this plan, the resource interval is expected to last approximately 34 years.

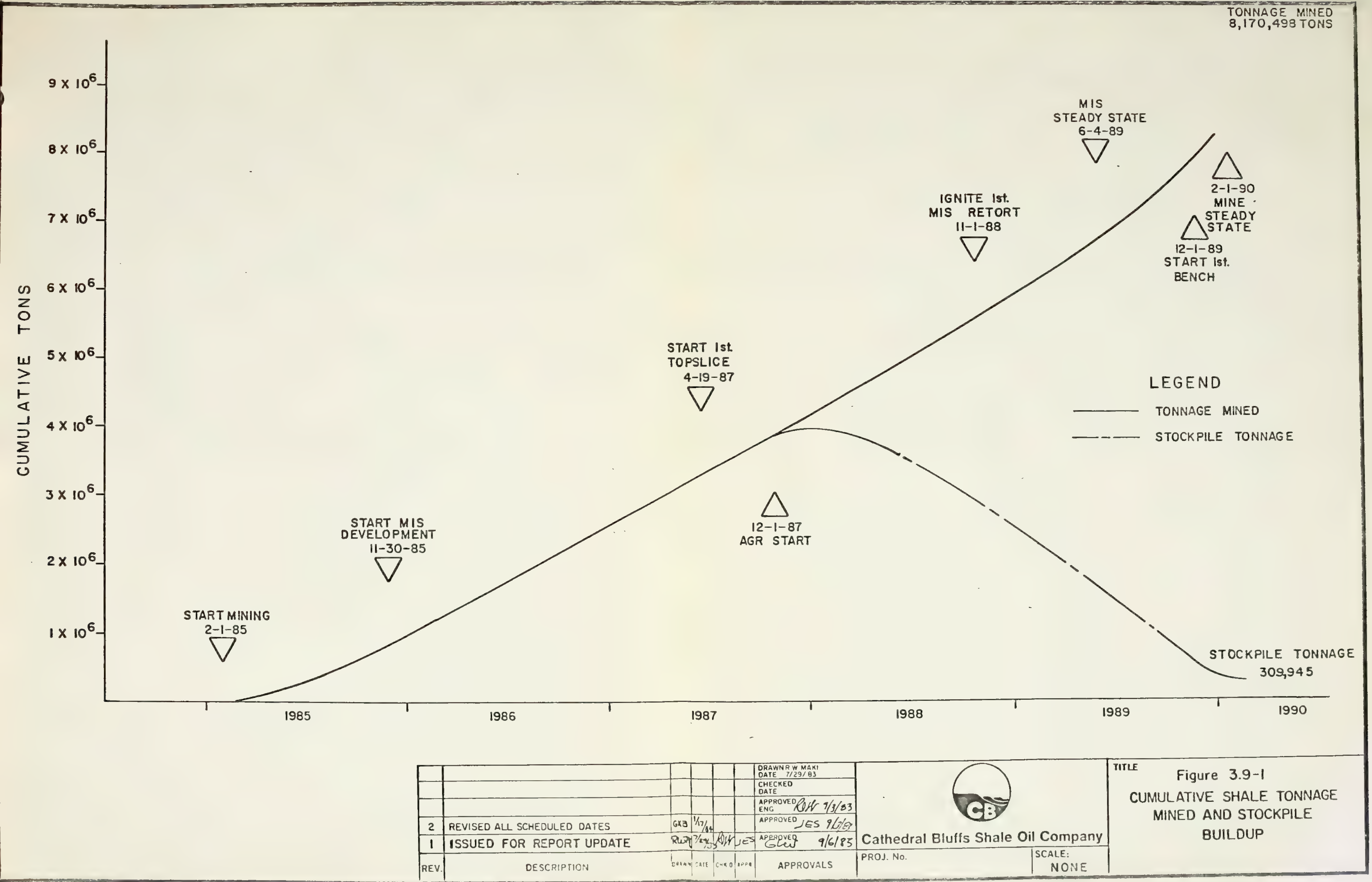
Figure 3.9-1 depicts the cumulative shale tonnage and stockpile growth produced under this plan through 1990. After this date, a constant 4.67 MM tons per year is expected to be mined. Details of the mining plan are in Section 3.3.

3.9.2 Resource Recovery

The portion of the Tract where mining is expected to take place contains an estimated 434.1 MM Bbls of raw shale oil in place within the mining horizon. A total of 148 MM Bbls of raw shale oil (equivalent to 158 MM Bbls of syncrude) is expected to be produced during the life of the Project (see Table 3.9-1).

3.9.3 Lease Production Requirements

Under Section 7 (e)(1) of the Oil Shale Lease, CB must pay minimum royalties. The royalties vary by the Lease year. The production rate for computing minimum royalty for the sixth lease year is 616,000 tons of oil shale containing 30 gpt of shale oil which increases linearly to 6,160,000 tons of oil shale in the fifteenth lease year (1990) and thereafter.



TITLE
Figure 3.9-1
CUMULATIVE SHALE TONNAGE MINED AND STOCKPILE BUILDUP

TABLE 3.9-1

CB Life and Production Under Project Development Plan

Period	Retort Feed Tons	Bbls* Syncrude Production
1. Feb. 1985 to May 1988	700,800 @ 33.5 gpt	582,000
2. June 1988 to June 1989	3,504,000 @ 34.5 gpt	3,194,000
3. July 1989 to July 1990	4,298,200 @ 36.5 gpt	4,752,000
4. Aug. 1990 to 2019	124,649,000 @ 40.0 gpt	149,248,000
TOTAL: 34 Years	133,152,000 @ 39.7 gpt	157,776,000

*Syncrude production includes MIS and AGR oil.
Total Raw Oil Production equals 148,341,000 Bbls.

3.0 PROJECT DESCRIPTION

3.9 Project Development Plan

The equivalent Project oil shale production at steady-state in 1990 is estimated to be 6,270,000 tons per year. This exceeds the minimum royalty. The calculations are presented in Table 3.9-2.

Offset credits are allowed from the sixth through tenth Lease year and have been utilized to meet minimum royalties. In the eleventh and twelfth years of the Lease, Project production is increasing and the minimum royalty will be paid if production does not meet minimum requirements for these Lease years. Production equal to minimum royalty is expected to be met by Lease year 13 (1988) and thereafter.

TABLE 3.9-2

Calculations of Annual Shale Tonnage

(1990 and Thereafter)

Room and Pillar Mine (Including MIS Void Rock)

12,800 tons/calendar day @ 40 gpt

MIS Mine

Gross heat of combustion from MIS oil production

2260 Bbl/calendar day x 42 gal/Bbl x 139,500 BTU/gal
= 1.324×10^{10} BTU/calendar day

Gross heat of combustion from MIS gas production

283.3×10^{6} BTU/hr x 24 hr/day
= 0.680×10^{10} BTU/calendar day

Total gross heat of combustion from MIS oil and gas

= $1.324 \times 10^{10} + 0.680 \times 10^{10} = 2.004 \times 10^{10}$ BTU/calendar day

Equivalent tonnage @ 30 gpt

2.004×10^{10} BTU/calenday day ÷ 152,700* BTU/gal ÷ 30 gpt
= 4375 tons/calendar day @ 30 gpt

Total

Room and Pillar Mine	= 12,800 tons/calendar day @ 40 gpt
MIS Mine (equivalent tonnage)	= 4,375 tons/calendar day @ 30 gpt
Total	= 17,175 tons/calendar day @ 37.5 gpt
17,175 tons/calendar day x 365 days/yr	= 6,270,000 ton/yr(1)

* Specified in CB Lease, Section 7(a) (1) (ii) (A) for 30 gpt shale.
(1) on a calendar-day basis, downtime is taken into consideration.

4.0

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4.0 ALTERNATIVES

4.1 Mining

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4.0 ALTERNATIVES

Section 4.0 describes alternatives that 1) are presently under consideration for early implementation, 2) may be considered in the future, and 3) may be feasible if the Project is expanded. Historic alternatives, those studied and discarded, are not addressed.

4.1 Mining

4.1.1 MIS Mining Alternatives

A possible multi-phased long-range development alternative is discussed in Section 4.6. Actual implementation will depend on economic, technological, environmental, regulatory and contractual considerations. Under the multi-phased approach, a second generation MIS design could be used for the first incremental expansion from the initial Phase I MIS design. Rectangular, rather than square, retorts would be used in the Phase II plan so that fewer bulkheads could be required and fewer acres could be developed per year. The conservative sizes of the cluster end pillars in the initial plan could be reduced but could still provide a non-subsiding mine design. A two- rather than three-void-level retort design could be used in this phase. The height of the retorts could be increased tentatively from 278 to 335 ft. to improve total production. Room and pillar mining is planned to be phased out.

Phase III in this scenario could consist of an incremental redesign of the basic mine plan, eventually resulting in minimal surface subsidence. A second aboveground retort could be constructed and the number of MIS retorts doubled so as to produce sufficient feed tonnage. This phase could involve reducing pillar sizes in a phased program with each step monitored and evaluated before the next step if pillar reduction were implemented. In Phases IV and V, a controlled subsidence mine design could be incorporated and used over the remainder of the Tract. One additional aboveground retort could be constructed during each phase, and the number of MIS retorts would be increased accordingly.

4.1.2 Bulk Mining Alternatives

If conventional mining is continued in combination with MIS mining, one of two bulk mining methods might be used: multilevel room and pillar mining or

blasthole stoping. Each of these methods would allow for increased recovery from thicker oil shale intervals although the overall grade of the shale mined would be reduced.

4.1.2.1 Multilevel Room and Pillar Mining

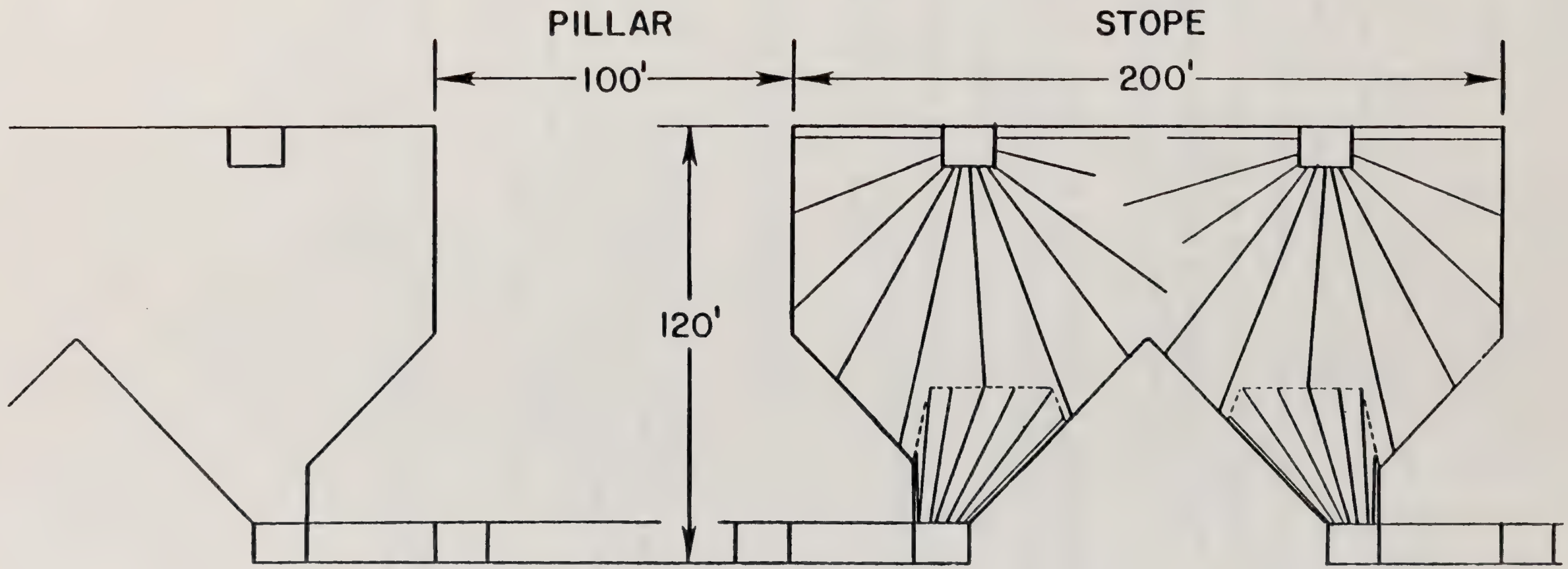
In a multilevel room and pillar mine plan there could be three mine levels, each located in high grade zones within an interval of approximately 345 feet.

Room heights could vary as shale grade varied and a non-subsiding mine design could continue to be used. The actual mine plan for each level could be similar to the present Room and Pillar Mine plan.

4.1.2.2 Blasthole Stope Mining

A dual mining level blasthole stope mining method with stopes 120 ft. high and 200 ft. wide (see Figure 4.1-1) is a common bulk mining technique that recovers greater amounts of in-place ore in thicker intervals than single or multilevel room and pillar mining. The method is, however, much less flexible to selective mining than the other methods, and the overall grade of the oil shale would be less than that of a multi-level room and pillar mine.

In the blasthole stope method, the chosen interval is mined by developing a mine level at the top of the interval for drilling, loading and shooting the stopes, and a level at the bottom of the interval to provide access to draw points at the bottom of the stopes and for hauling materials to the shaft. In the stopes, blastholes are drilled from the top to the bottom, loaded with explosives and then blasted. The ore is gravity fed to the drawpoints where it



DWG. No.	DESCRIPTION
REFERENCE	DRAWINGS

TITLE
DUAL MINING LEVEL BLASTHOLE STOPE MINING METHOD

FIGURE 4.1-1

Cathedral Bluffs Shale Oil Company

REV	DESCRIPTION	DRAWN	DATE	CHK'D	APPR	APPROVALS
						DRAWN DATE
						CHECKED DATE
						APPROVED ENG.
						APPROVED
						APPROVED

PROJ. No. SCALE: DWG. No. REV

is then hauled to the shaft for hoisting to the surface. A plan designed to support the overburden would be used. However, a typical block of ore mined by this method would be about 100 feet in height by 200 feet wide by 1000 feet in length. Such large mine openings will cave and cause some subsidence. Thus, the stope design would have to be modified, if necessary, to avoid caving effects. This could involve backfilling or designing narrower spans to eliminate significant caving by natural arch formation.

Because of access and rock withdrawal requirements, and the large tonnages per blast, the blasthole stope method generally has greater capital costs than room and pillar mining; however, the method provides lower mining-operation cost per ton. The mining section would be thicker, and the grade of the ore would be lower. Thus, the total mining operating cost per barrel could actually be higher than the room and pillar methods.

4.1.3 Relaxation of the Boundary Pillar

Section 13 of the Lease directs that where in situ methods are utilized fracturing shall not be induced to less than 100 feet from the Tract boundary. Such Lease restrictions may be relaxed if approved by the OSPO, and additional reserves could be mined. The current boundary pillar acreages are: MIS mining, 108 acres, and room and pillar mining, 87 acres.

The Project MIS mine is based on a 320 ft. setback and the room and pillar mine is based on a 75 ft. setback. Additional reserves for two cases with reduced pillars are shown below.

4.0 ALTERNATIVES

4.1 Mining

Case A - 50 ft. room and pillar setback and 100 ft. MIS setback

	Mining	Design	Additional Raw Shale Oil (Above the Base Project)
1.	R&P/MIS	Similar to present case	9.9 MM Bbls
2.	MIS	Best non-subsiding case	20.1 MM Bbls
3.	MIS	Controlled subsidence	29.5 MM Bbls

Case B - No boundary set backs

	Mining	Design	Additional Raw Shale Oil (Above the Base Project)
1.	R&P/MIS	Similar to present case	16.3 MM Bbls
2.	MIS	Best non-subsiding case	38.0 MM Bbls
3.	MIS	Controlled subsidence	55.8 MM Bbls

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4.2 Materials Handling

4.2.1 Underground Disposal of Processed Shale

Hydraulic backfilling of mine openings with processed shale has been studied as an alternative waste disposal method. Some principal advantages and disadvantages of hydraulic backfill, as might be utilized at Tract C-b, are listed below.

Advantages:

- Reduced amount of processed shale deposited of on the surface.
- Possible improved ground control with reduced surface subsidence (for Project Phases III and IV as discussed in Section 4.6).

Disadvantages:

- Additional costs for equipment and power required for the backfilling placement network.
- Large quantities of water required.

Hydraulic emplacement of mill tailings in a grout mixture has been in use at a number of North American metal mines since 1928. The possibility of underground disposal was discussed in the 1973 EIS for the Prototype Oil Shale Leasing Program, although the technical aspects of such a disposal system were not addressed.

The Denver Research Institute published a report on disposing processed shale ash in in situ retorts. Studies have also been undertaken at the U.S. Bureau of Mines (USBM) Spokane Research Center; the Colorado School of Mines Research Institute; Solinc, Inc.; and the Lawrence Berkeley Laboratory (LBL). These studies have presented a large amount of data on the physical and mechanical properties of several different oil shale grout mixes, although little emphasis has been placed on actual production and placement of such grout.

4.2 Materials Handling

The USBM and LBL have indicated that a water-to-solids weight ratio of 0.7:1 is necessary to prepare a suitable grout mix. Therefore, the amount of fill water required by the CB Project would be approximately 2,000 acre-feet per year. Approximately 820 GPM (1300 acre-ft./year) of excess water are presently available. According to the USBM, little or no water would be recovered after grout is injected. The costs of providing a backfill system and the additional water, are presently prohibitive. Such a system may be considered further at a later date.

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4.3 Aboveground Retorting (AGR)

4.3.1 Use of Shale Fines

The Union AGR does not process raw shale less than 1/8 inch in diameter ("fines"). As a result of mining and crushing operations, at least 8 percent of the raw shale mined for the AGR will be fines. Under near-term plans, these fines are planned to be discarded with the retorted shale.

Alternative means for recovering the energy value in the fines include:

1) additional development and modification of the present AGR to retort the fines,
2) use of an alternative or auxiliary AGR process to retort the fines, or
3) use of a fluidized bed reactor to recover the heating value.

The first alternative is currently being explored by The Union Oil Company, the developer of the AGR technology. This alternative represents the most direct solution to the problem of utilizing the fines. The production from fines would not be sufficient to support the latter two alternatives.

Separate storage of fines is not justified at the present time because:

1) The technology to retort the fines is not presently available and it is not known when it will be. Therefore, the size of an ultimate storage pile cannot be determined.

2) The additional cost of the separate handling and storing of fines, including the revegetation costs, is not economically justified.

3) The storage of fines represents a significant fire hazard; when fires have occurred in piles of oil shale fines, they have been difficult to extinguish and resulted in problems similar to oil spills.

4.3 Aboveground Retorting (AGR)

4.3.2 Use of Processed Shale Residual Char

The AGR unit to be used in the first phase of the CB Project does not fully utilize organic matter contained in the shale. Residual carbon remains on the processed shale which is discarded. The energy value of this residual carbon could be recovered by direct combustion of the char in the AGR Unit or by use of a fluidized bed reactor. Direct combustion of the char and utilization by the AGR facility of the heat and energy produced would reduce the demand for the high-BTU retort offgas which could then be sold for off-site use or converted to electricity.

The first alternative is being explored by the developer of the AGR technology and, for the same reason given in Section 4.3.1, is the preferred approach to improving overall energy efficiency of the process. Should a fluidized bed reactor become cost effective, both raw shale fines and processed shale char could comprise the feed.

4.3.3 Use of Calcined Shale

Calcined shale has cement-like properties, but does not have sufficient strength to replace concrete or the cement in concrete. It may be suitable as a structural fill material, however. It is classified impervious in soil engineering terms, and in a highly compacted state may provide a quality pond-lining material. If it were desirable to make a quality cement, further laboratory studies would have to be conducted to determine the extent of calcining that would be necessary and other factors. It is possible that the burning of the char could be an energy source for the calcining process.

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4.4 Upgrading

4.4.1 Off-Tract Upgrading

The Upgrading Facilities for the CB Project are sized to handle its production requirements. It is planned to upgrade the raw shale oil to a premium quality crude that can be transported in existing crude oil pipelines. If subsequent development phases of the Project are implemented and shale oil production increases, additional OUG capacity may be required. This additional capacity could be developed either on- or off-Tract.

The natural properties of raw shale oil from the AGR require pretreatment to improve pumpability. Pipeline owners desire to have potential contaminants removed that might contaminate other crudes. Raw shale oil carried in the pipeline tends to be a viscous, medium-gravity oil with high pour point, high-olefins content, low sulfur and high nitrogen and oxygen contents. Shale oil also contains relatively higher concentrations of metals (e.g., Fe, As) which poison certain refinery catalysts. For these reasons commingling raw shale oil with other pipeline crude oils is not acceptable.

The off-Tract option could become attractive as shale oil production from the basin increases, since it is possible that a shared pipeline could be constructed to transport raw shale oil from several producers to a central facility. That facility could include necessary upgrading or refining processes.

4.4.2 Use of Ammonia

Both the MIS and AGR facilities produce ammonia as a byproduct. The ammonia produced is of high quality, suitable for direct sale, as a reagent for in-Plant use or as a raw material for manufacturing ammonium nitrate for in-Plant use as explosives.

4.4 Upgrading

CB presently plans to market anhydrous ammonia (see Sections 3.7, 3.8.17, and 3.8.20). As the Project develops, alternative uses for this byproduct will be evaluated.

The ammonia could be used on-site to produce ammonium nitrate. Each week CB will use tons of ammonium nitrate for ANFO explosives. Ammonium nitrate could be made from either pure ammonia or ammonium sulfate. Ammonia is reacted with nitric acid to produce ammonium nitrate. It would be necessary to build a plant to produce nitric acid. The extra capital required to construct the ammonium nitrate facilities would be compared to the savings in operating costs to determine the feasibility of such an approach.

The long-term plan for byproduct sales and utilization will evolve following market evaluation, analysis of alternative reagent technologies, and further study of costs involved.

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4.5.1 Water Supply

In Section 6.3, Hydrology Control Plan, it is stated that CB's water supply from on-Tract groundwater is sufficient to meet Project needs. As a backup CB has secured water rights off-Tract; these are summarized and discussed below.

4.5.1.1 Summary of Cathedral Bluffs Water Rights

CB has secured water rights to the groundwater from the C-b Tract and to surface water from Piceance Creek and its tributaries (see Table 4.5-1). In addition, CB holds an option to purchase rights to the Powell Park Reservoir on the White River and to the Powell Park/ Piceance Creek pipeline. The Project has also secured the right, under Colorado water law, to store water on the site and on other areas close to the C-b Tract. These water rights, in the opinion of the CB engineering staff and consultants, Clifford H. Jex Engineers and Tipton and Kalmbach (1979), will yield several times more water than required by the Project.

With these rights to additional water, CB has an adequate margin of safety to deal with such contingencies as increased process demand, reduced groundwater resources, periodic low flow, and seasonal conditions.

4.5.1.2 Proximate Off-site Sources

In the unlikely event that water requirements exceed on-site groundwater supplies, off-site groundwater and surface water sources can be developed in accordance with CB's rights and priorities. CB could also purchase water from owners holding groundwater and surface water rights in the vicinity of the C-b Tract. It is estimated that there are supplies readily available that can provide several times the projected needs of the CB Project.

TABLE 4.5-1

Cathedral Bluffs Shale Oil Project
Status of Water Rights

Title	Water Court File No.	Use	Quantity	Priority	Conditional Decree	Status
1) White River-Piceance Creek Pipeline	W-225	Diversion supply augmentation	100 CFS	8-05-66	4-12-73	Diligence application approved 8/82 by Water Court.
2) Powell Park Reservoir	W-226	Storage	75970 AF	8-05-66	4-12-73	Diligence application approved 8/82 by Water Court.
3) Piceance Creek C-b Pipeline #1	W-3441	Diversion supply augmentation	1 CFS	8-20-77	5-08-79	0.111 cfs absolute. 0.889 cfs conditional diligence approved 2/82.
4) Augmentation Plan	W-3492	Plan for augmentation of depletion to senior rights	N/A	N/A	5-08-79	Detailed plan of augmentation due 4/85. Also petitioned to amend monitoring plan. Due diligence filing on groundwater rights filed 4/83.
5) Cb Dewatering System #1	W-3493	Dewatering water supply (Groundwater)	39664 gpm (88 CFS)	8-31-77	5-08-79	Due diligence filed 4/83. Wells A-3, ATI, and ATIA maintain original priority date of 9/07/76.
6) Scandard Gulch Reservoir	W-3494	Storage	5250 AF	4-30-75	5-08-79	Due diligence filed 4/83.
7) Willow Creek Reservoir #1	81-CW-133	Storage	6000 AF	6-03-81	Pending	Stipulation agreed with objectors and referred to court for action.
8) Hunter Creek - Willow Creek Pipeline	81-CW-134	Diversion supply augmentation		6-03-81	Pending	Same as 81-CW-133.
9) Hatch Gulch Reservoir	82-CW-149	Surge reservoir for W-225	10,000 AF	1982	12/82	
10) Piceance Creek/ Willow Creek Pipeline	83-CW-160	Diversion of winter flows and spring runoff from Piceance Creek for storage in Willow Creek Reservoir (81-CW-133)	15 CFS			Application submitted 6/23/83

4.5 Utilities and Off-site Facilities

4.5.1.3 Powell Park Reservoir and White River/Piceance Creek Pipeline

Cathedral Bluffs holds options to purchase rights to the strategically located Powell Park Reservoir site on the White River and to the Powell Park-Piceance Creek Pipeline. The Powell Park Reservoir right is for storage of 75,970 acre-feet of water and the Powell Park-Piceance Creek Pipeline right is for a diversion flow of 100 cfs. (To the degree possible, the pipeline would follow other utility corridors such as the product pipeline route.) CB also holds a right of way option for the diversion station at the decreed diversion point and pipeline on private land.

4.5.1.4 Yellow Jacket Project

Cathedral Bluffs is a participant in the Yellow Jacket/White River Project feasibility analysis. The Yellow Jacket Project would include diversion and provisions for storing water from the White River above the confluence of Piceance Creek. The Yellow Jacket/White River Project Study is being carried out by the State of Colorado in connection with the Yellow Jacket Conservancy District and a number of industrial developers. The U. S. Bureau of Reclamation is also actively supporting this study.

Preliminary findings by International Engineering Co., the contracting engineer for the Yellow Jacket/White River Study, demonstrate the feasibility of a project to utilize water rights held by oil shale developers and that such rights will yield sufficient water for projected production plans. The project would assure additional water supplies for domestic and agricultural uses in the area.

4.5 Utilities and Off-site Facilities

4.5.2 Product Transportation

Several alternative routes for the product pipeline are under consideration. Refer to Section 3.8.18.

4.5.3 Power Generation

As indicated in Section 4.3, alternative Project facilities could improve energy recovery from the oil shale. Such additional energy could best be utilized for on-site electrical power generation. If, however, additional MIS retorts come on line, the available quantities of offgas will exceed that necessary for on-site steam generation; thus on-site power generation would be appropriate for utilization of the energy. Studies of this application have shown potentially favorable economics. All on-site power requirements could be met, and some excess power would be available for sale.

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4.6 Long-range Development

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4.6.1 Phased Long-range Development

The plan presented in Section 3.0 represents what CB considers to be the most cost effective and technologically feasible approach to initially producing syncrude from Tract C-b. When it becomes feasible and prudent, CB will consider initiating a phased expansion of the Project subject to the appropriate approvals by the U.S. Department of Interior, the U.S. Synthetic Fuels Corporation, and all other appropriate federal, state and local regulatory agencies. The specifics of phased expansion will depend on many factors: technology, economics, approvals, environmental considerations, etc. A possible approach, however, is as follows:

Phase I of such an expansion could be the development of the Tract for approximately 10 years from the start of mining coinciding approximately with the planned guaranteed debt retirement date under the plan proposed herein (Section 3.9).

Under Phase II, a second generation MIS design could be employed, and room and pillar mining would be phased out. The surface retort would continue to operate, but with MIS void ore only. Rectangular, rather than square, retorts could be used so that fewer bulkheads would be required and fewer acres would be developed per year. The conservative size of the cluster end pillars in the initial plan could be reduced based on actual data analysis but would still provide a non-subsiding mine design. A two- rather than three-void-level retort design might be used in this phase and the height of the retorts could be increased from 278 to 335 ft. to improve overall recovery. Development under this phase could also last approximately 4 years.

4.6 Long-range Development

Phase III could consist of an incremental redesign of the basic mine plan, eventually resulting in a minimal subsidence mining system. This phase could involve reducing pillar sizes in a phased program with each step carefully monitored and evaluated before the next step in pillar reduction is implemented. A second AGR could be utilized and the number of MIS retorts doubled to produce sufficient feed tonnage. This phase could last approximately 4 years.

In Phases IV and V a controlled subsidence mine design could be incorporated and used over the remainder of the Tract. One additional AGR could be constructed and utilized during each phase and the number of MIS retorts increased accordingly. Phases IV and V would provide a greatly improved resource recovery with sufficient support of the overburden to prevent significant and abrupt surface disturbance over the Tract life. These phases would last approximately 4 and 20 years, respectively.

Table 4.6-1 lists the five development phases described above, along with the associated raw shale oil production for each.

In the event selected AGR methods or design operating conditions are determined to be inappropriate, or unacceptable for any reason, alternatives could be to modify AGR operation, expand the MIS development or adopt a new AGR technology or some combination of all.

4.6.2 Resource Recovery

The C-b Tract contains 5,094 acres, entirely underlain by kerogen-bearing strata. The layout of the mine designates a plant pillar of approximately 418 acres beneath which production mining will be prohibited (see Figure 3.3-2). Below ground this will provide an undisturbed area for underground service facilities; on the surface, it will be the location of critical process facilities. In addition, the C-b Lease stipulations require that there be no mining within a minimum of 50 ft. of the property boundaries and that MIS retorts and any induced fracturing therefrom be a minimum of 100 ft. from the property boundaries. These boundary pillars account for an additional 195 acres, leaving a net of 4,481 acres available for development.

TABLE 4.6-1

CB Phased Long-range Development

Mining Plan	Type of Mining	Acres Used	Years (Begin 1984)	Annual Raw Shale Oil MM Bbls	Cumulative Raw Shale Oil** MM Bbls	Acres Remaining @ Completion	Raw Shale Oil Remaining MM Bbls
Initial Phase I Plan	Room and Pillar and MIS	935	10*	4.84	32.2***	3546.	979.8
Phase II	1- AGR MIS Only; Non-Subsiding	188	4	9.2	69.0	3358.	943.0
Phase III	2- AGR MIS Only; Minimal-Subsiding	322	4	18.8	144.2	3036.	867.8
Phase IV	3- AGR MIS Only; Controlled-Subsiding	400	4	28.7	259.0	2636.	753.0
Phase V	4- AGR MIS Only; Controlled Subsiding	2636	19.7	38.2	1012.	0	0

* Coincides with planned guaranteed debt retirement date.
** Does not include increased production from reduced boundary setbacks discussed in Section 4.1.3.
*** Includes production during 5 years buildup period.

4.6 Long-range Development

The room and pillar mine plan outlined in Section 3.0 provides for a non-subsiding mine, thereby necessitating that 33% of the in-panel rock remain as support pillars. The MIS mine plan is a very conservative plan utilizing panel and barrier pillars to maintain a non-subsiding design. If the proposed (Phase I) plan were to be used for the entire Tract, approximately 148 million barrels of raw shale oil (equivalent to 158 million barrels of syncrude) would be recovered and the Tract life would be 34 years. See Table 3.9-1.

In terms of increasing production from the Tract, the modified in situ technology in concert with aboveground retorting offers the most practical approach to maximize resource recovery and Tract life; and it is the basis for the phased development approach. As shown in Table 4.6-1, approximately 1,012 million barrels of raw shale oil would be recovered over 42 years by using the phased plan. The oil-in-place that corresponds to that plan is 2,783 million barrels for the 335 ft. thick section over the 4,481 minable acres.* Thus, the phased plan results in an overall resource recovery value of 36% for the entire minable Tract area.

* This is roughly comparable to the 1973 EIS which yields a value of 3,137 million barrels based on the same minable acres for a 350 ft. thick section.

4.0 ALTERNATIVES

References

References

Clifford H. Jex Engineers and Tipton & Kambach, Inc. Engineers (1979): Plan for the Water Supply for Development of Oil Shale Industry in White River Basin, Colorado.

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5.1 Introduction/Summary

Capital and operating cost estimates include all engineering, design, procurement, construction, start-up, and operating costs for a 14,100 BPCD shale oil production facility. The Project will utilize a Room and Pillar Mine, a four retort modified in situ (MIS) system, a single Unishale "B" Aboveground Retort, Oil Upgrading, and utilities and off-site facilities including a syncrude pipeline to Rangely, Colorado.

The Project has been segregated into four principal areas for cost estimating purposes. These areas are Room and Pillar Mining, MIS Mining, Surface Facilities, and unallocated/support costs.

As outlined in the July 28, 1983 Term Sheet between CB and the U.S. Synthetic Fuels Corporation, the construction cost of the CB Project, excluding expenditures prior to January 1, 1984, is estimated to be $1,810 million (as-spent dollars).

The following subsections identify the major cost categories and the method used to estimate costs.

5.0 COSTS

5.2 Mining

The mine costs include the following elements

1) underground facilities,
2) new shafts including headframes, hoisting plants, and related facilities;
3) underground distribution system for fire water, potable water, mine service water, and power; and
4) delivery system for oil shale and mine water.

The following items are not included in the estimate of Mine costs:

1) buildings and other Mine Support Facilities located above ground, and
2) non-mining construction of MIS retorts and the offgas shaft.

The following subsections outline the general approach used to develop cost estimates for mining.

5.2.1 Capital Costs

5.2.1.1 Headframe and Shaft Outfitting

The costs for the headframe and shaft outfitting were derived from the results of a 1982 CB project engineering report and estimate by Dravo and from in-house estimates.

5.2.1.2 Underground Mining and Construction

The costs of mining and construction were derived by first estimating the time required to perform specific work tasks. From this, a manpower buildup and equipment list were determined. Drawings of the various levels were developed to

quantify the footage of mining to be accomplished. Total costs were estimated from the various work task times, footage of mining, number of employees, pieces of equipment and their appropriate costs per foot or per hour.

5.2.2 Operating Costs

5.2.2.1 Direct Labor Manning

The method used to determine manpower requirements (Section 5.2.1.2) was also used to select the appropriate number of operating units and the manpower necessary to operate equipment.

5.2.2.2 Labor Availability

Based on Project experience to date and the assumption that the Union Parachute Creek Project will be the only other active oil shale operation in the area, labor will be available to meet the CB Project requirements.

5.2.2.3 Bulk Materials

The materials consumed during mining operations were estimated based on the quantity of work to be performed. The costs for the materials were taken from Project historical data and vendor quotes.

5.2.2.4 Utilities

Mine utility costs were based on the unitary costs of electrical power (White River Electric Association), natural gas (West Slope Natural Gas Company) and water (on-site resources and treatment).

5.0 COSTS

5.3 Surface Facilities

The costs of Surface Facilities include six key components: Materials Handling, Aboveground Retorting, MIS Process Facilities, Oil Upgrading, and utilities and off-sites.

The Surface Facilities capital and operating cost estimate, with the exception of the MIS Processing Facility, was developed by the CB project engineering department. This group used factors and estimating expertise developed from prior engineering estimates by CB and its engineering contractors: Fluor Engineers and Contractors, Inc., Bechtel Corporation, Stearns-Roger, and Dravo Engineering. The MIS Processing Facilities portion of the estimates was developed by the Bechtel Corporation.

Direct field costs for the Surface Facilities have been broken into direct field equipment and material, direct field labor, and bulk material and subcontract costs. These costs are summarized into several primary accounts for direct field cost.

All materials and labor that are directly related to the purchase and erection of a piece of equipment are treated as part of permanent Surface Facilities and are included in the direct field costs.

In addition, there are indirect field costs which include all field costs that support the direct field activity: temporary construction, unallocated labor, field administration and craft labor payroll burden, sales tax, and estimated construction fees. The indirect field costs for this estimate are based on historical percentages of direct field labor. Also, there are office costs for engineering and design, and for engineering contractor management (home office and field).

5.0 COSTS

5.3 Surface Facilities

Costs for start-up include allowances for construction craft personnel and equipment and licensor personnel to support the plant start-up and commissioning operation through mechanical completion. Maintenance materials, spares, chemicals, catalysts, and consumables are also included as well as fuel and utility requirements.

Sales tax includes Colorado sales at 3% of direct field equipment and material. A 2% county use tax is included for building materials.

5.4 Unallocated/Support Costs

The unallocated/support costs, which consist primarily of general and administrative costs, include expenditures for such items as in-house staff for project management, insurance and ad valorem taxes, and certain operations and maintenance not included in the Mine or Surface Facilities estimates. The costs for staffing and directing socioeconomic activities, environmental activities, and the construction man camp are included in this category.

Revegetation is included in the environmental activities cost category. Revegetation costs exclude the disposal of processed shale but include the capital and operating costs required to establish and maintain vegetation until it is self-supporting. The primary capital and operating costs items are as follows: fertilizer, sewage sludge, topsoil, seed and transplants, mulch, irrigation, fences, maintenance of capital items, and evaluation of the revegetation program. Detailed cost breakdowns are presented in the CB Mined Land Reclamation Permit Application Amendment to be submitted to the MLRB in 1984. The estimated cost of revegetation is approximately $5,000/acre (1983 dollars).

5.0 COSTS

5.5 Contingencies

Contingencies were separately applied to each major component of the capital cost estimate. The contingencies were selected with the assistance of a computer simulation which inspected estimate accuracy and project scope and risk elements for the various account codes.

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6.0 ENVIRONMENTAL EFFECTS AND CONTROL PLANS

6.1 <u>Introduction/Summary</u>

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6.0 ENVIRONMENTAL EFFECTS AND CONTROL PLANS

6.1 Introduction/Summary

The Lease Environmental Stipulations specify that management plans be developed for fish and wildlife, spills, and rehabilitation (includes reclamation and erosion). It also requires that the rehabilitation plan be updated annually. The objective of these plans is to set forth methods that will be used to avoid and mitigate adverse environmental effects.

CB has developed the required plans as well as plans for several other environmental issues addressed in the Environmental Stipulations. Each environmental control plan contains a description of 1) those Project activities that will affect the environment, 2) associated regulations and permits, 3) programs to avoid or mitigate effects, and 4) anticipated environmental effects after mitigation.

The plans described below are necessarily in varying stages of maturity. For example, Project development to date has generated surplus water; therefore, the water quality control plan has been specified and implemented. The subsidence control plan, however, is preliminary and will not be finalized until commercial mining commences.

The plans identify programs that are or will be carried out. The details of some of these programs are (will be) contained in supportive documents, such as the Prevention of Significant Deterioration (PSD) permit and Mined Land Reclamation Plan permit. As supportive documentation is developed it will be forwarded to the OSPO.

Several years of data gathering and analysis have generated extensive information on potential environmental effects. The key effects and mitigating measures are summarized for construction (Table 6.1-1) and operation (Table 6.1-2), and include the following: (1) the nature or source of the impact; (2) the mitigating measure to offset the impact; (3) when applicable, the control effectiveness of air pollution control technologies; and (4) a cross-reference to other sections of this document which discuss the specific control plans.

TABLE 6.1-1

Environmental Effects and Mitigation - Construction Phase[1]

Impact Class[2]	Nature or Source of Impact	Measures[3]	Control Effectiveness[4]	Control Plan Section No.
Air	1. Fugitive dust			6.2
	a. Access road	Road paved (8/78) (Fugitive Dust Permit, 1982)	100% effective	
	b. Roads and parking areas	Application of Water and palliatives to roads as needed to control fugitive dust. Main roads and parking areas shall be paved when average daily traffic counts exceed 165 vehicles over any consecutive three day period. (Fugitive Dust Permit, 1982)	- Water - 50% - Palliative - 85%	
	c. Earth moving operations and other earth disturbances	Erosion Control and Rehabilitation Plan (6/77, updated 11/80) - Topsoil stockpiling - Revegetation - Irrigation	 - Revegetation and irrigation - 100% effective	6.8
		Fugitive dust permit - Water application; apply binding agent to disturbed ground after leveling and excavation	- Water - 50%	
		Mined Land Reclamation Plan (3/78, construction state only) - Minimizing disturbances - Land reclamation		6.5
	2. Corridor traffic exhaust	Project van pooling or bussing; reduce speed limit	- About 90% of project staff are expected to ride buses during construction and 75% during operations	7.4
	3. Temporary power generator exhaust	None (Controls not required on generators with less 1000 hp)	N/A	
	4. Cement batch plant dust	Baghouses have been installed (Fugitive Dust Permit)	99.5% effective	6.2
Water	5. Effects on surface and ground water resulting from disposal of mine shaft water	Primary measures: - Storage in 2 holding ponds to control sediment and flow - Discharge into East No Name Gulch (NPDES Permit 8/83)[5] Standby measures: Storage in 3rd pond to provide surge control for - - Sprinkling (OSPO, Land Application System Plan 1980)	N/A	6.3, 6.4

TABLE 6.1-1

Environmental Effects and Mitigation - Construction Phase[1] (Continued)

Impact Class[2]	Nature or Source of Impact	Measures[3]	Control Effectiveness[4]	Control Plan Section No.
Water (Cont.)	6. Lowering of water table (zone of influence) resulting from mine dewatering. The goal is to protect senior water rights in vicinity of Tract by preventing depletions.	Water augmentation plan (1980)[6] - Monitoring and modeling efforts - Releases to surface stream if required - Reinjection in selected deep wells - Future diversion and storage of water	N/A	6.3 4.6
	7. Spills of oil and other hazardous materials	Spill prevention control and countermeasure plan	N/A	6.6
	8. Disposal of domestic sewage	On-site sewage treatment plant (9,000 gal/day) operated in accordance with state permit	N/A	6.7, 3.8.5
Land	9. Surface disturbances	(Refer to Impact #1c and measures described under Erosion Control and Rehabilitiation Plan and Mined Land Reclamation Plan)	N/A	6.5, 6.8
	10. Erosion	Erosion Control and Rehabilitation Plan - Sediment basins constructed to contain 25-yr floods and control 100-yr floods - Revegetation	N/A	 6.8 6.5
Ecology	11. Habitat loss	Fish and Wildlife Plan (June 1977) - Habitat conversion to increase forage productivity to offset losses incurred due to disturbance elsewhere (102 acres converted to date) - Habitat restoration (revegetation)	N/A	 6.11 6.5
	12. Road kills of wildlife	Fish and Wildlife Plan sets forth several measures (e.g., fencing) that will be implemented if deemed necessary by OSPO. Project busing. Joint road reflector study with Dept. of Wildlife in progress.	N/A	6.11
Health	13. Mine air quality contaminants	Compliance with all MSHA regulations7	N/A	6.15

TABLE 6.1-1

Environmental Effects and Mitigation - Construction Phase[1] (Continued)

Impact Class[2]	Nature or Source of Impact	Measures[3]	Control Effectiveness[4]	Control Plan Section No.
Health (Cont.)	14. Mine physical agents	Compliance with all MSHA regulations[8]	N/A	6.15
	15. Construction accidents	Surface and underground construction will be accomplished in compliance with all applicable regulations.[9]	N/A	6.15

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1 Unless noted otherwise, this table addresses the major impacts of those construction activities that occur on the C-b Tract before commercial operations commence.

2 Impact Class describes the environmental medium affected or the topic of the impact.

3 Mitigating Measure refers to those techniques, regulations, and management and control plans that will ameliorate impacts.

4 Control Effectiveness is stated only for the air pollution control technologies utilized.

5 Hearings held by the State WQCC resulted in a combined classification for Piceance Creek that includes the criteria for Class II agricultural use and warm water biota, and Class II recreation.

6 Cathedral Bluffs monitors water levels in many wells on- and off-Tract. The data are made available annually to the Water Court and other interested parties.

7 The MSHA regulations that apply are as follows: 30 Code of Federal Regulations (CFR) 57, 5-1, 2, 3, 5, 6, 10, 15, 16 18B, 18D, 18F, 20, 22, 25, 27, 28, 29, 31, 32, 34, 35, 37 through 42, 44 through 47.

8 The MSHA regulation that applies to 30 CFR 57.5-50.

9 Accident rates lower than the national average are anticipated. Cathedral Bluffs policies provide for constant efforts to reduce accident frequency.

TABLE 6.1-2

Environmental Effects and Mitigation - Operation Phase[1]

Impact Class[2]	Nature or Source of Impact	Measures[3]	Control Effectiveness[4]	Control Plan Section No.
Air	1. Air quality			6.2
	a. Fugitive dust	- Baghouse - Water palliatives - Chemical palliatives - Covered conveyors - Underground conveyors	- 99.5% removal of TSP - 50% suppression of TSP - 85% suppression of TSP - 90% control of TSP - 99% control of TSP	
	b. Mine vents	- None at vent	- N/A	
	c. Aboveground Retort	- Heaters, boilers - Unisulf - Retort feed baghouse	 - 99.9% H_2S removal - 99.5% TSP removal	
	d. Upgrading emissions	- Claus and Low NO_x Burners, fuel gas cleaning	- 98% SO_2 removal - 95.9% NO_x reduction	
	e. Tank farm emissions	- Floating roofs or equivalent	- 95% HC collection	
	f. MIS Emissions	- Double-alkali FGD units	- 98.4% SO_2 removal	
	2. Visibility degradation	- Control is indirect via air quality measures[5]	- Same as air quality control measures	
Water	3. Zone of influence from mine dewatering	(Refer to comments under Impact #6 in Table 6.1-1)	N/A	
	4. Surface and groundwater pollution resulting from mine dewatering and effluent from process streams			

TABLE 6.1-2

Environmental Effects and Mitigation - Operation Phase[1] (Continued)

Impact Class[2]	Nature or Source of Impact	Measures[3]	Control Effectiveness[4]	Control Plan Section No.
Water (Cont.)	a. Mine waters	Excess waters treated in settling ponds for pH and suspended solids and discharged under NPDES permit	N/A	6.4
	b. Retort waters and process condensate	Process waters and wastewaters will be used for on-site requirements; i.e. no impact.	N/A	
	c. Processed shale leachate	Processed shale pile to be wetted with 10 to 16% water. A ditch to collect any leachate and surface runoff will be cut around spent shale pile during the construction period. The ditch will direct waters to downdip catchment dam for settling and if necessary, treatment. Additional updip diversion structures will be located in the gulch to prevent precipitation runoff from entering the pile. Compacted retorted shale blankets are used both over and beneath the pile; that over the pile reduces the rate of moisture infiltration into or out of the pile and enhances stability of the exterior pile slopes. Monitoring groundwater to detect infiltration and/or leaching effects, if any.	N/A	6.3, 6.4, 6.8
	d. MIS Retorts	- Monitoring of groundwater, geologic, and hydrologic conditions to determine if the MIS process operations have any measurable effect on quality of nearby groundwater. - Monitoring to confirm chemistry of effluent drainage water from MIS retorts as a function of time after retorting. - Collection of effluent drainage, treatment as necessary, and use of feedwater. - Further characterization of MIS processed shale.	N/A	6.4
	e. Effects on surface and groundwater from disposal of mine shaft water.	(Refer to comments under Impact #5 in Table 6.1-1)	N/A	
5.	Spills of oil and other hazardous materials	(Refer to comments under Impact #7 in Table 6.1-1)	N/A	

TABLE 6.1-2

Environmental Effects and Mitigation - Operation Phase[1] (Continued)

Impact Class[2]		Nature or Source of Impact	Measures[3]	Control Effectiveness[4]	Control Plan Section No
Land	6.	Disposal of domestic sewage	(Refer to Impact #8, Table 6.1-1)		
	7.	Potential disposal of hazardous wastes	The project may produce wastes and handle materials that are classified as hazardous. Wastes will be disposed of at approved disposal facilities off-site by approved contractors in accordance with requirements of the Resource Conservation and Recovery Act.	N/A	6.7
	8.	Disposal of retorted shale	Mined Land Reclamation Plan and Procedures. - Revegetation - Contouring terrain, but topography permanently altered (1200 acres ultimately)	N/A	6.5
	9.	Susbidence	Non-subsiding mine design, and monitoring[6]	N/A	6.9
	10.	Surface disturbances	(Refer to Impact #1c, Table 6.1-1, and measures described under Erosion Control and Rehabilitation Plan and Mine Reclamation Plan)	N/A	
	11.	Erosion	(Refer to comments under Impact #10, Table 6.1-1)	N/A	
Ecology	12.	Wildlife habitat loss and road kills	(Refer to comments under Impact #11 and #12, Table 6.1-1)	N/A	
Health and Safety	13.	Dust generation from mining operations	Dust control program. Wetting or use of dust palliative in haulage tunnels[7], working face wetting, water screens, proper ventilation	N/A	6.15
	14.	Chemical vapor generation from AGR process	Use BACT to minimize any emissions and apply appropriate work practice and personal protective equipment controls if necessary to assure personnel exposure levels below applicable TLVs ([8])	N/A	6.15

TABLE 6.1-2

Environmental Effects and Mitigation - Operation Phase[1] (Continued)

Impact Class[2]		Nature or Source of Impact	Measures[3]	Control Effectiveness[4]	Control Plan Section No.
Health & Safety (Cont.)	15.	Noise from fans and mining equipment	Specify BACT before equipment is purchased and retrofit other equipment as necessary. Main vent fans will be located on the surface with booster fans underground, all fans will be specified to have the lowest feasible noise generation. Hearing protection used in noise hazard areas in accordance with MSHA/OSHA regulations.[9]	N/A	
	16.	Radiation exposure	MSHA has taken measurements at the C-b Tract and found no radon daughters present.[10]	N/A	
	17.	Diesel emissions during underground operations	Use best available emission control technology along with a good preventive maintenance program and adequate ventilation.[11]	N/A	6.15
	18.	Ground Control	Use modern ground control techniques and equipment consistent with 30 CFR 57.3-20 and other applicable standards.[12]	N/A	6.15
	19.	Fire Prevention and Control	Provide best available fire control equipment, procedures, and training as specified by Lease and 30 CFR 57.4. Maintain on-site surface and underground mobile fire fighting equipment and trained operating personnel.[13]	N/A	6.14, 6.15
	20	Safety programs	The Safety Program will exceed all mandatory requirements and will receive full management support and participation.	N/A	6.15
	21.	Chemical vapor generation from MIS retorting	The MIS retorts are operated under negative pressure so that vapors cannot enter the Mine.	N/A	3.7
	22.	Burning underground	MSHA exemption to be obtained, mitigate in accordance with MSHA requirements, control burning rate through process control measures.	N/A	3.7

TABLE 6.1-2

Environmental Effects and Mitigation - Operation Phase[1] (Continued)

[1] This table addresses the impacts that would result from commerical operation that occur after initial construction activities are concluded.

[2] Impact Class describes the environmental medium affected or the topic of the impact.

[3] Mitigating Measure refers to techniques, regulations, and management and control plans that will ameliorate impacts.

[4] Control Effectiveness is stated only for air pollution control technologies utilized.

[5] The project will cause a minor impact on visibility. It is estimated that visibility will be degraded by 1.5%. The measured pristine visual range of 130 kilometers will therefore be reduced by 2 kilometers.

[6] Mine pillars will shorten in response to increase stress but the effects on the surface will be unnoticeable and aquifers will not be disrupted.

[7] A dust control program will be developed as a part of the Cathedral Bluffs Occupational Health Program in accordance with MSHA regulations.

[8] Sometimes processing facilities experience upset conditions due to equipment failure of other factors; higher than normal emissions may result for a brief period.

[9] A noise control plan will be developed as a part of the Cathedral Bluffs Occupational Health Program.

[10] Monitoring for radon daughters will be continued according to MSHA regulations even though initial measurements showed none were present.

[11] A diesel exhaust monitoring program will be included as a part of the Cathedral Bluffs Occupational Health Program.

[12] Operating experience on similar ground conditions at the Logan Wash mine will benefit the CB Program.

[13] Fully trained and equipped mine rescue terms will be available for mine emergency situations.

6.0 ENVIRONMENTAL EFFECTS AND CONTROL PLANS

6.2 Air Quality

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LIST OF FIGURES

LIST OF TABLES

6.0 ENVIRONMENTAL EFFECTS AND CONTROL PLANS

6.2 Air Quality

6.2.1 Emission Sources

Activities and processes affecting air quality include:

1) mine operations and ventilation,
2) materials handling,
3) aboveground retorting (AGR),
4) modified in situ (MIS) processing,
5) oil upgrading, and
6) general arrangement of surface facilities (as it affects ambient concentrations).

These activities have been discussed in detail in previous sections. For convenience, Table 6.2-1 identifies the activity, cites the section which describes the activity, identifies the process, describes the process and cross-references the figures presenting process flow diagrams. The "translation" of these qualitative processes into quantitative emission sources is discussed in Section 6.2.3.

6.2.2 Regulations and Permits

The following section discusses Lease provisions, federal and state laws and regulations applicable to the Project and describes the actions which will be taken to comply with such requirements. Where permits are required, their status is given.

6.2.2.1 Lease Requirements

Section 11 of the Lease and Section 8 of the Lease Environmental Stipulations require compliance with all applicable federal, state and local air pollution and air quality regulations.

ACTIVITY	SECTION/ SUB-SECTION	ITEM OR PROCESS	DESCRIPTION	FIGURE	BRIEF TITLE
Mine Operations	3.3	Mine Vent	Ventilation of gases and particulates from mine.	-	
Materials Handling	3.4	Raw Shale Handling	Conveying, transferring, crushing and screening, storing, controling wind erosion and disposing of raw shale.	3.4-1	Process Flow
	3.4	Processed Shale Handling	Conveying, transferring, storing controling wind erosion and disposing of processed shale.	3.4-1	Process Flow
Aboveground Retorting (AGR)	3.5	Aboveground Retorting	Union Oil Co. Unishale B process. Heated crushed shale fed by a rock pump to where retorting takes place; retorted solids then withdrawn, cooled and moisturized.	3.5-1	Block Flow Diagram
MIS Processing	3.6	Flue Gas Desulfurization (FGD)	Two trains of boilers, steam generators, FGD absorbers and slurry circulators. Two boilers and stacks. FGD unit is double alkali unit.	3.6-1	Block Flow Diagram
Upgrading	3.7	Oil Upgrading	Union Oil Co.'s ugrading process. Pretreatment to remove excessive nitrogen, sulfur and arsenic. Lower oil pour point for better pipelining. Produces high quality syncrude.	3.7-1	Block Flow Diagram
General Arrangement	3.2	Surface Facilities	General arrangement of surface facilities affects ambient concentrations.	3.2-2, 3.2-3, and 3.2-4	Plot Plans

TABLE 6.2-1 Activities and Processes Affecting Air Quality

6.0 ENVIRONMENTAL EFFECTS AND CONTROL PLANS

6.2 Air Quality

6.2.2.2 Air Quality Regulations and Standards

6.2.2.2.1 Categories of Regulations

Air regulation categories are depicted on Table 6.2-2. They include ambient ("surrounding air") and emission source ("stack") standards. New Source Performance Standards (NSPS) have been promulgated industry-by-industry; the oil shale industry does not yet have NSPS at the federal level so Best Available Control Technology (BACT) applies for pollutants above de minimis levels as specified by the EPA. BACT is part of the Prevention of Significant Deterioration (PSD) regulations under the Clean Air Act. State of Colorado NSPS have been promulgated.

6.2.2.2.2 Ambient Air Quality Standards

At the federal level the National Ambient Air Quality Standards (NAAQS) define maximum permissible ground level concentrations of "criteria" pollutants: SO_2, CO, NO_2, O_3, TSP and Pb. They have been promulgated to protect public health and welfare and are of particular importance because they define the maximum permissible level of pollutants from the proposed operations.

NAAQS are shown on Table 6.2-3 and expressed in terms of values not to be exceeded more than once per year with the exception of ozone. The ozone standard is stated in terms of the number of annual expected exceedances of one-hour-maximum values which must be less than 1.0 when averaged over a consecutive 3 year interval. The annual particulate standard represents the geometric mean of 24 hour values.

"Ambient" air according to 40 CFR 50.1 (e) is defined as "that portion of the atmosphere, external to buildings, to which the general public has access". For the present application, NAAQS and PSD standards are applied at the Tract boundary which corresponds to the public-access location.

TABLE 6.2-2 Air Regulations Categories

Category	Definition	Pollutants
Ambient Standards	Measured in the open air as absolute values.	"Criteria Pollutants" - SO_2, CO, NO_2, O_3, TSP, Pb
Emission (Sources) Standards (Called New Source Performance Standards) (NSPS)	Measured inside the stacks as absolute values.	SO_2, TSP, CO, NO_x
Where NSPS are not Promulgated - as for Oil Shale - Best Available Control Technology (BACT) applies under PSD	Highest degree of control technology available at practicable cost (emission controls)	Pollutants above PSD de minimis levels as specified by the EPA are subject to BACT - they include criteria pollutants above plus asbestos, Be, Hg, vinyl chloride, benzene, radionuclides, inorganic As, sulfuric acid mist, H_2S, total reduced sulfur, reduced S compounds
Prevention of Significant Deterioration (PSD) Increments	Incremental ambient values at ground level due to plant operations as obtained by computer modeling (applicant plus previously permitted sources).	SO_2, TSP

TABLE 6.2-3

National Ambient Air Quality Standards

Pollutant	Primary or Secondary	Averaging Time	Standard (ug/m^3)
SO_2	Primary	Annual	80(1)
	Primary	24-Hour Maximum	365
	Secondary	3-Hour Maximum	1300
TSP	Primary	Annual	75(2)
	Primary	24-Hour Maximum	260
	Secondary	Annual	60(2)
	Secondary	24-Hour Maximum	150
CO	Primary	8-Hour Maximum	10,000
	Primary	1-Hour Maximum	40,000
NO_2	Primary	Annual	100
O_3	Primary	1-Hour Maximum	235(3)

(1) Arithmetic mean of 24-hour values
(2) Geometric mean of 24-hour values
(3) Annual expected number of exceedances must be less than 1.0 over 3-year consecutive interval.

6.2 Air Quality

CB facilities must also comply with the Colorado Air Quality Control Act (CAQCA) and regulations set by the Colorado Air Quality Control Commission (CAQCC). Permits for emissions of pollutants to the atmosphere are required. The Colorado regulations have also established overall ambient air quality standards for CO, TSP, SO_2 and NO_x. These state levels are generally more stringent than the national standards (NAAQS). In the case where a facility is in compliance with both the state emission standards and the PSD program, the State of Colorado does not enforce its ambient standards but rather treats them as goals.

6.2.2.2.3 New Source Performance Standards (NSPS) and Emission Standards

State NSPS and Emission Standards are summarized on Table 6.2-4. Because Federal NSPS are not yet promulgated for oil shale, BACT applies. In-stack sampling is required to determine compliance with TSP and SO_2 criteria. Table 6.2-4 contains both state emission standards and non-federal NSPS.

The state permitting requirements for particulate emissions for point sources are governed by specified fuel burning curves for new fuel burning equipment and new manufacturing processes. Aboveground Retorting and oil upgrading are covered by these regulations. All sources of particulates must employ BACT which also provides compliance with the state regulations. Fugitive dust emissions are also controlled by application of BACT.

The Colorado Air Quality Control Commission has adopted NSPS under State Regulation 6 of 0.3 lb SO_2 per barrel of oil production from oil shale facilities. Under this regulation use of BACT is required. In 1981 the CAQCC revised the emission limit to allow some flexibility to oil shale production facilities that employ AGR and MIS (where at least 20% of the total production derives from the aboveground retorting process). The exemption requires use of BACT "with total daily SO_2 emissions not to exceed the emissions which would result from operation of the facility at design capacity (expressed in barrels of oil produced per stream day) multiplied by 0.3 lbs SO_2 per barrel."

TABLE 6.2-4 New Source Performance and Emission Standards State of Colorado - Non-Federal NSPS

Category	Pollutant	Limit	Standard
New Fuel Burning Equipment (Reg. 1)	TSP	<1 x 10^6 BTU/hr >1 x 10^6 BTU/hr and <250 x 10^6 BTU/hr " "	0.5 lbs/10^6 BTU PE = 0.5 $(FI)^{-0.26}$ PE=emissions (lb/10^6BTU/hr) FI=fuel input (10^6BTU/hr) 20% Opacity
New Manufacturing Processes (Reg. 1)	SO_2	N/A	2.0 tons/day or BACT
New Sources SO_2 (includes oil shale) (NSPS-Reg. 6)	SO_2	All <1000 Bbl/day >1000 Bbl/day	0.3 lbs/Bbl - Petroleum Refinery None - Production of shale oil 0.3 lbs/Bbl - Production of shale oil

6.2 Air Quality

The applicant for the AGR/MIS "exemption" must prove that "it intends and has the capability to construct and operate a shale oil production facility with the design capacity claimed in the permit application". Another provision allows the Division to cut the "design capacity" to "actual production capacity" should the Division determine subsequently that the facility has not been built to the claimed design capacity, or the facility does not have the capability of being operated at the design capacity. The employment of BACT is determined by the Air Quality Control Division.

This exemption will terminate in 1992, at which time full compliance with the NSPS is required unless an extension is granted by the CAQCC. Shale oil upgrading plants are allowed to emit a separate 0.3 lbs. SO_2 per barrel under State Regulation 6 NSPS. Thus, a total of 0.6 lbs of SO_2 per barrel, 0.3 lbs for retorting and 0.3 lbs for upgrading, is permitted.

The CAQCC regulations for hydrocarbons require the installation of floating roofs or their equivalent on hydrocarbon storage tanks of 40,000 gallons or more.

6.2.2.2.4 Prevention of Significant Deterioration (PSD)

Allowable federal PSD increments are presented in Table 6.2-5 for SO_2 and particulates. Compliance is determined by computer air diffusion modeling. The C-b Tract is located in a Class II area. Federal increments for Class II apply in most areas off-Tract. The nearest Class I area is the Flattops Wilderness area approximately 57 km to the east; Mt. Zirkel, another Class I area, is 110 km from the Tract. Class I increments must be met at wilderness area boundaries.

PSD regulations require consideration of all pollutants regulated under the Clean Air Act of 1977. The August 7, 1980 changes to PSD regulations set forth a list of the regulated pollutants and their *de minimis* values. *De minimis* values

TABLE 6.2-5

Air Quality PSD Increments for SO_2 and Particulates

Federal Prevention of Significant Deterioration (PSD) Standard	Maximum Allowable Increment ($\mu g/m^3$)				
	SO_2			TSP	
	3-Hour	24-Hour	Annual	24-hour	Annual
Class I	25	5	2	10	5
Class I	512	91	20	37	19
Class III	700	182	40	75	37

are thresholds, not standards. Those emissions that exceed the de minimis values are subject to BACT assessment. De minimis values, total CB emissions, and CB emissions subject to BACT are shown for comparison on Table 6.2-6.

Another regulated area under PSD (in addition to PSD increments, use of BACT, and de minimis values) is the protection of Air Quality Related Values (AQRVs). The only specific AQRV called out in the Clean Air Act is visibility; others to be specified include dry and wet deposition, often referred to as "acid rain".

6.2.2.3 Permit Status

CB has received the PSD permit and the state emission source permits called APEN's, adding the AGR and OUG facilities to the original ancillary PSD.

Application for amendment to the PSD permit and for the MIS APEN's which will revise BACT for MIS Surface Processing Facilities will be submitted in August 1984. Experience indicates that these permits should be issued before mid 1985.

6.2.2.4 Potential Additional Requirements

Although not regulatory in nature, additional environmental monitoring requirements have been proposed in "Interim Environmental Monitoring Plan Guidelines of the U.S. Synthetic Fuels Corporation" set forth in the Federal Register (Vol.48, No.64/Friday, April 1, 1983, pp 14108-14113). CB expects to obtain a loan guarantee from the SFC, and therefore will incorporate the SFC monitoring guidelines into its monitoring program. The SFC has proposed that several water and airborne pollutants that are not presently addressed by any regulatory body be monitored. Additional details on air monitoring are presented in Section 8.6.

6.2.3 Emissions Inventory and Control Plan

6.2.3.1 Pollutant Applicability

CB emission rates for CO, NOX, SO_2, and TSP are subject to BACT analysis because they exceed de minimis levels (see Table 6.2-6). Calculations of these numerical values are contained in the CB PSD permit-amendment application to the EPA (Cathedral Bluffs, 1982b).

6.2.3.2 Control Strategy

The CB control strategy is based on BACT. A complete discussion on BACT analysis is beyond the scope of this DDP but is contained in the PSD permit application. Control techniques are described in Section 3.4 for materials handling, 3.5 for aboveground retorting, 3.6 for MIS processing, 3.7 for oil upgrading, and 3.8 for utilities (e.g., tank farm).

6.2.3.3 Emissions Inventory and Control Plan

The general location of emissions sources is presented on the plot plan in Figure 6.2-1. Raw and processed shale piles are shown on Figure 6.2-2.

Table 6.2-7 presents the controlled emission rates, each type of control system, its percent efficiency and location. Stack characteristics are presented in Table 6.2-8.

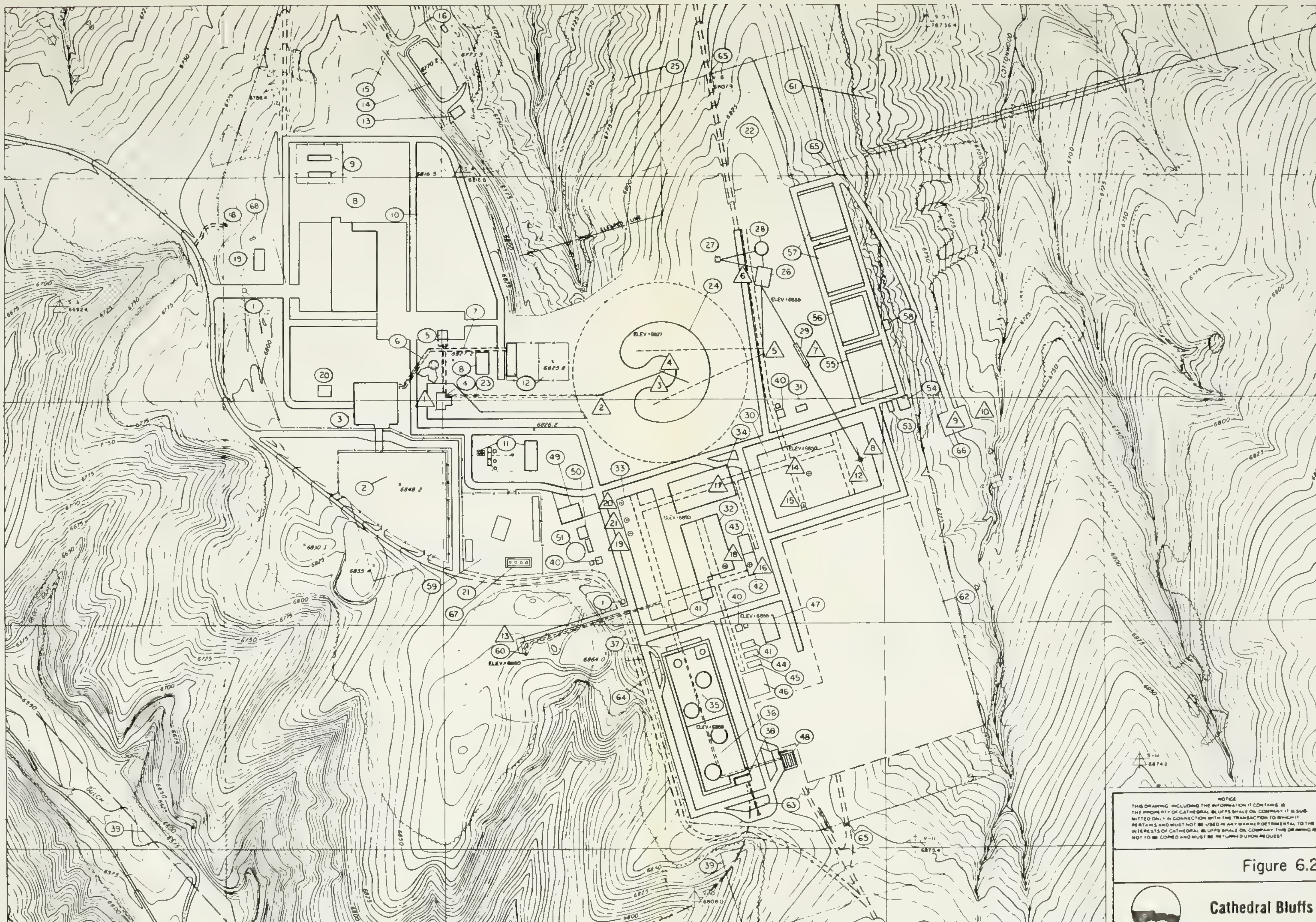
Total controlled emissions for the entire on-Tract facility are summarized on Table 6.2-9.

TABLE 6.2-6

Regulated Pollutants and De Minimis Values (Tons/Yr)

Pollutant	De Minimis Emission Rate	CB Emission Rate
Carbon Monoxide	100	205*
Nitrogen Oxides	40	1950*
Sulfur Dioxide	40	654*
Particulate Matter	25	1198*
Ozone	40 of VOC	<40
Lead	0.6	0.15
Asbestos	0.007	0
Beryllium	0.004	0
Mercury	0.1	0.003
Vinyl Chloride	1.0	0
Fluorides	3	7.8
Sulfuric Acid Mist	7	0
Hydrogen Sulfide	10	0
Total Reduced Sulfur	10	0
Reduced Sulfur Compounds	10	0

* With Controls



LEGEND

- EMISSION SOURCE
- EQUIPMENT IDENTIFICATION

NOTES:

1. FACILITIES CORRESPONDING TO PLOT PLAN CODE NO'S ARE IDENTIFIED IN TABLES 6.2-7 & -8.

INTERFACING CONTRACTOR(S)		
CONTRACTOR(S)	CONCURRENCE	DATE

Figure 6.2-1

Cathedral Bluffs Shale Oil Company

DRAWN BY	J. HITCHENS
[illegible]	12/8/82
[illegible]	12/8/82
[illegible]	[illegible]
[illegible]	[illegible]

PLOT PLAN SHOWING POINT EMISSION SOURCES

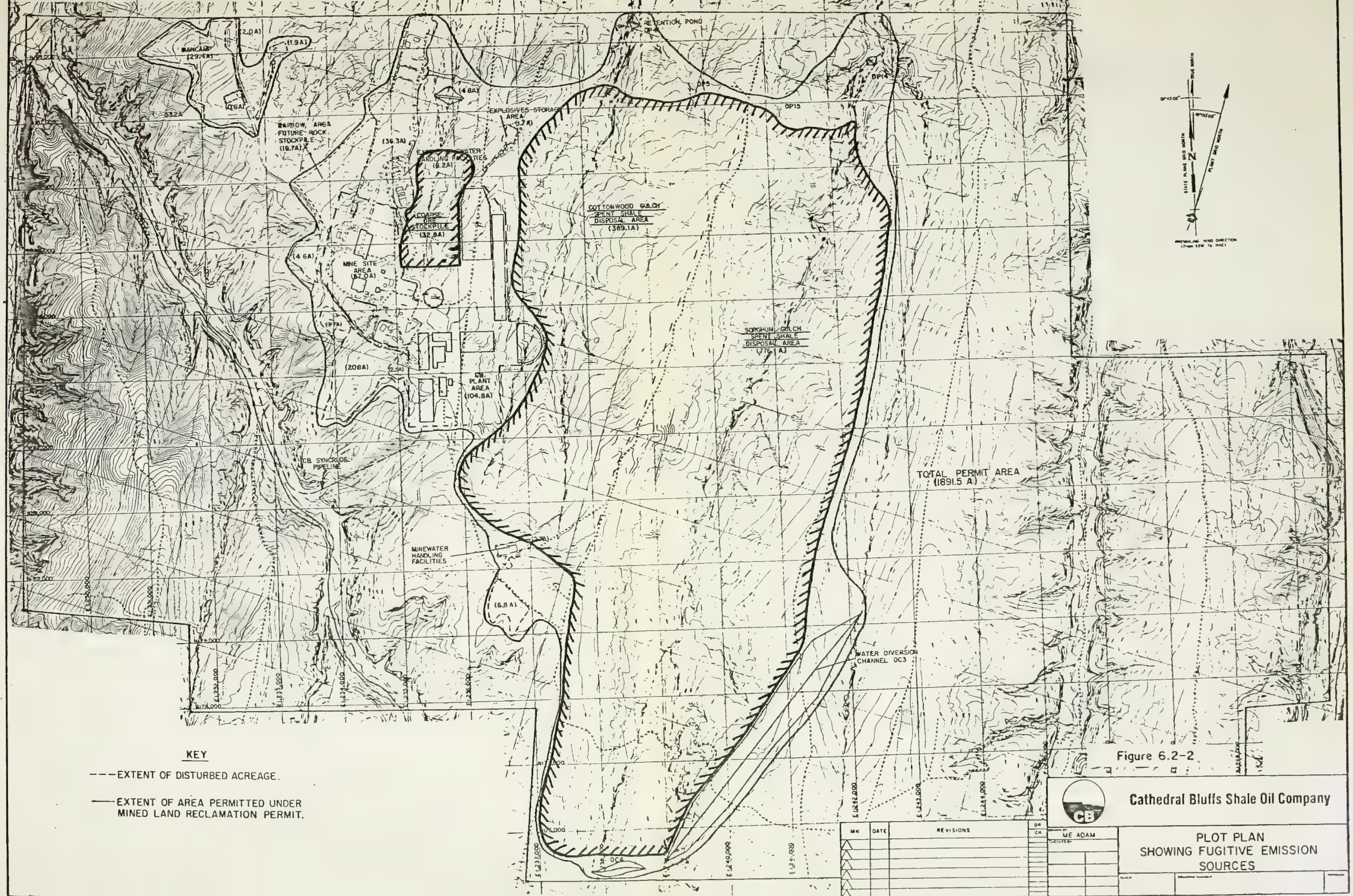
REVISION 0

MK	DATE	REVISIONS	DR	CH	STRUCT	VESSELS	PIPING	ELEC	APP	INTERFACE

MK	DATE	REVISIONS	DR	CH	STRUCT	VESSELS	PIPING	ELEC	APP	INTERFACE

NUMBER	REFERENCE DRAWINGS

REDUCED PRINT SCALES



KEY

---EXTENT OF DISTURBED ACREAGE.

——EXTENT OF AREA PERMITTED UNDER MINED LAND RECLAMATION PERMIT.

Figure 6.2-2

Cathedral Bluffs Shale Oil Company

MK	DATE	REVISIONS

ME ADAM

PLOT PLAN
SHOWING FUGITIVE EMISSION
SOURCES

TABLE 6.2-7 Controlled Emission Rate (gm/sec)/ Type of Control/ % Control/ Location

a. Point Sources

Unit	TSP/Control	SO_2/Control	NO_x/Control	CO/Control	HC/Control	Plot Plan Code No.*	Section Containing Process Description
Reformer Furnace	0.37/none	0.91/FC/98	25.7/FC/95.9	0.62/GC/--	0.11/GC/--	18	3.7.3
Oil Charge Heater	0.061/none/none	0.15/FC/98	1.39/FC/95.9	0.103/GC/--	0.017/GC/--	19	3.7.3
H_2 Recycle Heater	0.012/none/none	0.03/FC/98	0.28/FC/98.9	0.02/GC/--	0.003/GC/--	21	3.7.3
H_2 Charge Heater	0.037/none/none	0.09/FC/98	0.86/FC/95.9	0.065/GC/--	0.013/GC/--	20	3.7.3
Recycle Gas Heater	0.33/none/none	0.82/FC/98	7.66/FC/95.9	0.57/GC/--	0.10/GC/--	14	3.5.3
Sponge Oil Reboiler	0.04/none/none	0.11/FC/98	1.00/FC/95.9	0.07/GC/--	0.01/GC/--	15	3.5.3
Retort Flare (Pilot)	0.001/none/none	0.015/FC/98	0.029/FC/95.9	0.002/--/--	0.0/--/--	12	3.5.3
Process Flare (Pilot)	0.001/none/none	0.16/FC/98	0.029/FC/95.9	0.002/--/--	0.0/--/--	13	3.5.3
Steam Boilers Sum of 2 Units	0.50/none/none	17.58/FGD/98.5	8.40/FC/95.9	0.90/GC/--	0.05/GC/--	16	3.6.3
Transfer House	0.2/IB/99.5					2	3.4.3
Stacker Conveyor	0.56/CS/85					4	3.4.3
Transfer House	0.2/IB/99.5					3	3.4.3
Reclaim Drawhole	0.06/IB/99.5					5	3.4.3
Crushing Bldg.	0.036/IB/99.5					6	3.4.3
Screening Plant	0.033/IB/99.5					7	3.4.3
Retort Feed Conveyor	0.053/IB/99.5					8	3.4.3
Retorted Shale (1) Transfer House	0.46/none/--					9	3.4.5
Retorted Shale (2) Conveyor Discharge	0.46/none/--					10	3.4.5
Production Shaft Mine Vent (3)	1.96/none/--	0.67/none/--	10.5/none/--	3.5/none/--	0.87/none/--	1	3.3.3
Cement Batch Plant	0.05/IB/99.5	0.26/none/--	0.025/none/--	0.03/none/--	0.0/none/--	11	3.3.10.7

Key:

FC - Fuel Cleaning
GC - Good Combustion Practice
IB - Insertable Baghouse
CS - Chemical Spray
FGD - Double Alkalai Scrubber For Fuel Gas Desulfurization

Notes:

(1)(2) Retorted shale transfer house handles spent shale that as a minimum contains 10% moisture.
(3) Dust control is applied in the mine in accordance with MSHA requirements utilizing wet suppression techniques.
* See Figure 6.2-1

TABLE 6.2-7 (Cont'd)

b. Fugitive Dust Emission Sources

(gm/sec)

	Control/%	Annual*	24-Hour*
Haul Roads	W/50	0.035	0.035
5-Day Raw Shale Storage Pile	W/50	0.01	0.10
Spent Shale Pile - Sorghum Gulch	W/50,R	1.70	17.75
Spent Shale Distribution-Sorghum Gulch	W/50	0.85	8.9
5-Year Raw Shale Storage Pile	W/50	0.12	1.24
Retorted Shale Conveyor Discharge	W/50	0.46	0.46
Stacker Conveyor	W/50	0.56	0.56

Key - Control

W = Water

R = Revegetation, except for Working Face

* Some sources differ for Annual and 24-Hour rates due to presence of snow cover for the Annual case.

TABLE 6.2-8 Stack Characteristics

Plot Plan Code No.*	Unit	Stack Ht. (m)	Exit Temp. (°K)	Exit Vel. (mps)	Exit Dia. (m)	Vol. Flow (m^3/sec)
18	Reformer Furnace	49.50	450.	13.8	2.130	49.50
19	Oil Charge Heater	49.50	450.	13.9	0.924	10.20
21	H_2 Recycle Heater	49.50	450.	12.4	0.413	2.04
20	H_2 Charge Heater	38.10	450.	13.8	0.762	6.31
14	Recycle Gas Heater	91.44	506.	13.7	2.290	56.02
15	Sponge Oil Reboiler	53.30	402.	13.4	0.760	6.09
16	Utility Steam Boilers (2)	69.0	346.	36.6	1.78	115.8
1	Production Mine Vent	9.75	288.	12.7	8.84	566.00
11	Cement Batch Plant	5.50	589.	15.7	0.510	3.21
2	Transfer House		Ambient		0.50	
4	Stacker Conveyor	15.24	Ambient		-	
3	Transfer House		Ambient		0.50	
5	Reclaim Drawhole		Ambient		0.30	
6	Crusher Building		Ambient		0.95	
7	Screening Plant		Ambient		0.90	
8	Retort Feed Conveyor		Ambient		0.30	
9	Retorted Shale Transfer House		Ambient		0.30	
10	Retorted Shale Conveyor Discharge		Ambient		-	

*See Figure 6.2-1

TABLE 6.2-9

Total Controlled Emissions on C-b Tract

Constituent	gm/sec	lb/hr	TPD	lbs/Bbl[1]
SO_2	18.8	149	1.79	0.25
NO_x	56.0	444	5.34	0.76
CO	5.87	46.5	0.56	0.08
TSP-24 hr. (2)	34.5	273	3.28	0.47
TSP Annual (2)	9.17	72.7	0.87	0.12

(1) Based of 14,100 Bbls/calendar day
(2) Differ due to nature of fugitive emissions

6.0 ENVIRONMENTAL EFFECTS AND CONTROL PLANS

6.2 Air Quality

6.2.3.4 Demonstration of Compliance with Air Quality Regulations

6.2.3.4.1 Compliance With PSD

PSD compliance is demonstrated by comparison of air diffusion computer model results with the allowable PSD increments as presented on Table 6.2-5.

CB used the EPA Valley Model which is widely accepted for rough-terrain air diffusion modeling studies and addresses both short-term and annual non-reactive-pollutants. The results of this model have been judged to be conservative by a factor of 2, Roth et. al., (1975).

Modeling results include:

1) short-term and annual examination of both SO_2 and TSP for Class I and Class II as obtained from modeling CB on-Tract facilities;

2) additional effects of the previously permitted sources shown on Table 6.2-10; and

3) secondary emissions from towns in the region and traffic along roads.

Results of this work are summarized on Table 6.2-11 where column 5 pertains to item 1) above, column 6 to the sum of 2) and 3), and column 7 to the sum from all sources. Column 7 is less than the PSD limit (Column 8) indicating compliance. Potential effects at the Flattops and Mt. Zirkel Class I areas as well as other off-Tract areas were modeled.

TABLE 6.2-10

Previously Permitted Sources and Their Distances From CB

Source	Permitted Size	Approximate Distance from CB (mi)	(km)
Craig Power Plant	Units 1, 2, 3	62	100
Chevron	100,000 Bbl/day	16	26
Colony	47,000 Bbl/day	13	21
Union	90,000 Bbl/day	12	19
C-a	Approximately 7,000 Bbl/day	18	29
Mobil	100,000 Bbl/day	12	19

TABLE 6.2-11 Demonstrated Compliance with PSD Increments (ug/m^3)

(1) PSD Class	(2) Location for Maximum Concentration	(3) Pollutant	(4) Averaging Time	(5) Maximum Modeling Increment: CB	(6) Maximum Modeling Increment: Permitted and Secondary Sources	(7) Maximum Modeling Increment: Total	(8) PSD Limit
I	Flattops	SO_2	Annual	0.01	1.25	1.26	2
			24-Hour	0.12	0.25	0.37	5
			3-Hour	0.30	0.63	0.93	25
		TSP	Annual	0.01	0.61	0.62	5
			24-Hour	0.05	0.47	0.52	10
I	Mt. Zirkel	SO_2	Annual	0.006	0.27	0.28	2
			24-Hour	0.005	0.38	0.39	5
			3-Hour	0.013	0.98	0.99	25
		TSP	Annual	0.002	0.10	0.10	5
			24-Hour	0.012	0.12	0.13	10
II	Off-Tract	SO_2	Annual	3.6	0.5	4.1	20
			24-Hour	15.5	0	15.5	91
			3-Hour	38.8	0	38.8	512
		TSP	Annual	1.3	0.2	1.5	19
			24-Hour	4.9	0	4.9	37

6.2.3.4.2 Compliance with NAAQS

Because NAAQS are absolute values of the pollutants, demonstration of compliance requires the summation of the incremental effects of the Project and maximum ambient background levels measured at the Tract. Background levels have been measured at the Tract since inception of the Baseline program in 1974. Maximum levels for the last three years are representative and are presented in Table 6.2-12. These three years have been averaged in the column labeled "Background" in Table 6.2-13. The summation of the background levels and the maximum modeled increments from the Project does not exceed NAAQS (see Table 6.2-13). Ambient air quality monitoring, as discussed in Section 8.6, will be used to verify these predictions over the Project life.

6.2.3.4.3 Compliance with Colorado NSPS

The state regulation allows 0.3 lbs/Bbl of SO_2 for shale oil production facilities (i.e. the AGR plus the MIS) and another 0.3 lbs/Bbl of SO_2 for petroleum refinery facilities (the Oil Upgrader). Comparisons of Project emissions with this standard are presented in Table 6.2-9; the Project value is 0.25 lbs/Bbl for combined retorting and upgrading.

6.2.4 Environmental Effects

6.2.4.1 Impacts on Air Quality

Ambient air quality changes are identified in Section 6.2.3. Pollutants expected to enter the atmosphere in significant quantities during the operation of the Tract C-b facilities are those that exceed de minimus levels (see Table 6.2-6).

TABLE 6.2-12

Maximum Background Levels Measured at the C-b Tract and Their Comparison with National Ambient Air Quality Standards (Station AB23)

Applicable Ambient Air Standards	Constituent	Averaging Time	Standard Limit (ug/m^3)	Maximum Reading (ug/m^3)		
				1980	1981	1982
Primary	SO_2	Annual	80	1.0	1.5	1.4
		24-Hour	365	11.9	17.3	13.0
Secondary	SO_2	3-Hour	1300	13.1	18.3	15.7
Primary	NO_2	Annual	100	1.0	10.3(1)	2.7
Primary	Particulates	Annual	75*	6.7	10.2	7.5
		24-Hour	260	58.4	86.2	51.4
Secondary	Particulates	Annual	60*	6.7	10.2	7.5
		24-Hour	150	58.4	86.2	51.4
Primary	CO	8-Hour	10,000	3000	1800	200
		1-Hour	40,000	3800	1800	600
Primary	Oxidant (O_3)	1-Hour	235(2)	154	155	143

*Geometric Mean
(1) <50% Data
(2) Standard is exceeded if $\geq$ 3 expected exceedances occur above this value over a 3-year interval.

TABLE 6.2-13

Demonstrated Compliance with NAAQS
(ug/m^3)

(1) Pollutant	(2) Averaging Time	(3) Maximum Modeling Impact+	(4) Background(1)	(5) Sum*	(6) NAAQS
SO_2	Annual	4.1	1.0	5.1	80 (2)
	24-Hour	15.5	12.3	27.8	365
TSP	Annual	1.5	11.4	12.9	75 (3)
	24-Hour	4.9	81.5	86.4	260
CO	8-Hour	5	2167	2172	10,000
	1-Hour	12	2833	2845	40,000
NO_2	Annual	46.7	4.4	51.1	100
O_3	1-Hour	0**	185	185	235++

* = Modeling Impact Plus Background.

\+ = Includes Permitted and Secondary Sources.

** = Ambient O_3 Concentrations are Scavenged by NO_x Emissions from CB; therefore, Contribution is Negative.

++ = Annual Expected Number of Exceedances must be less than 1.0 over 3-Year Consecutive Interval.

(1) Average over 1980-1982.

(2) Arithmetic Mean of 24-Hour Values.

(3) Geometric Mean of 24-Hour Values.

6.2 Air Quality

The locations and levels of maximum expected pollutant concentrations are summarized on Table 6.2-14. Most of the maximums will be experienced at Collins Overlook which is approximately 5 miles north-northwest of the meteorological tower or 3-1/2 miles from the northern boundary of the Tract. Model calculations (PSD) show that the emissions will be in concentrations that comply with both ambient and incremental air quality standards. Compliance with established standards will ensure that environmental impacts are precluded or minimized. The maximum expected ground level concentrations are anticipated to occur primarily within the pinyon-juniper woodland community, with the exception of the short-term particulate impact which will occur in the chained pinyon-juniper rangeland.

Recently air impacts have been stated in terms of Air Quality Related Values (AQRVs). The only AQRV explicitly delineated in the Clean Air Act is visibility. Others implicitly inferred, according to recent regulatory agency interpretations, include effects on flora and fauna by the criteria pollutants and by dry and wet deposition ("acid rain"). These are discussed below.

6.2.4.2 Effects on Soils, Vegetation and Wildlife

6.2.4.2.1 Categorization of Soils and Vegetation

Soils in the vicinity of the C-b Tract have been intensively sampled, analyzed physically and chemically, and described according to standard soil classification techniques. The characteristics of each of the soil types are discussed in detail in the Final Baseline Report (C-b Shale Oil Venture, 1977) and summarized in Section 2.2. Pertinent features of the soils in the area of maximum expected concentrations are as follows:

Soil Characteristic	Value
Cation exchange capacity (CEC)	30.5 meq/100gm
Ratio of organic matter	3%
pH	7.2 to 8.6 8.2 (average)

TABLE 6.2-14

Maximum Expected Off-tract Concentrations for Pollutants That Are Expected to Exceed De Minimis Levels

Pollutant	Averaging Time	Concentration ug/m^3	Concentration ppm	Location
SO_2	24 hours	28	0.014*	Collins Overlook
	Annual	5	0.003**	Collins Overlook
TSP	24 hours	86		N. Tract Boundary
	Annual	13		Collins Overlook
NO_2	Annual	51	0.038**	Collins Overlook
CO	1 hour	2833	2.5*	Collins Overlook
	8 hours	2167	1.9*	Collins Overlook

* Converted from ug/m^3 at 288°K and 789 mb

** Converted from ug/m^3 at 274°K and 782 mb

Soil Characteristic	Value
Calcium concentration	4380 ppm (average)
Exchangeable sodium	1.1 to 7.9% 2.1% (average)

Categorization of vegetation in the vicinity of the C-b Tract has identified 14 plant communities. Detailed descriptions of these plant communities and the major species comprising them are presented in Section 3.3 of the Final Baseline Report. Table 6.2-15 lists species present on or near the C-b Tract that are known to be sensitive to the air pollutants. In all cases sensitivity thresholds are much greater than the maximum concentrations expected from C-b emissions.

Wildlife is not as sensitive to air pollutants as vegetation, consequently any effects on flora would be apparent before effects on fauna. Wildlife population and the productivity of vegetation are monitored regularly. Based on the systems dependent approach to monitoring, if changes are detected in either, the other will also be analyzed for effects.

6.2.4.2.2 Effects on Soils

The EPA has published criteria for the sensitivity of soils to acid precipitation (McFee, 1980). Soils with an average cation exchange capacity (CEC) greater than 15.4 meg/100 gm and highly calcareous soils, such as those found in the vicinity of C-b are classified as nonsensitive. Consequently, no effects are expected in the areas of maximum expected concentration. At further distances, concentrations decrease and impacts should not be discernible.

TABLE 6.2-15

Flora of Tract C-b Sensitive to Air Pollutants

Common Name	Scientific Name
TREES, SHRUBS, AND VINES	
Douglas-Fir	*Pseudotsuga menziesii*
Narrow-leaf cottonwood	*Populus angustifolia*
Oregon grape	*Mahonia repens*
Serviceberry	*Amelanchier alnifolia*
Snowberry	*Symphoricarpos orephilus*
Wild rose	*Rosa woodsii*
Willow	*Salix* sp.
HERBS	
Alfalfa	*Medicago sativa*
Darnel (Perennial ryegrass)	*Lolium perenne*
Evening primrose	*Calylophus Hartwegii ssp. lavandulifolium Oenothera trichocalyx, Oenothera* sp.
Goosefoot	*Chenopodium Fremontii, Chenopodium* sp.
Indian ricegrass	*Oryzopsis hymenoides*
Phacelia	*Phacelia idahoensis*
Scarlet gilia	*Ipomopsis aggretata*

6.2.4.2.3 Effects on Vegetation and Wildlife

The available literature on environmental effects of air pollutants on native vegetation and wildlife is limited because most research on effects has been done on agronomic crops, livestock, and ornamental plants as noted in U.S. Fish, Wildlife, and their Habitats (Dvorak et al., 1978). Review of the National Park Service (NPS) Bibliography of Air Quality Effects on Natural Ecosystems (Howard et al., 1980) identified documents that are pertinent to the effects of low concentrations of air pollution on the semi-arid ecosystems of the CB region. These included the paper by Hill et al. (1974) and the State of Montana Air Quality Standards Environmental Impact Statement (Montana, 1979). The EPA Air Quality Criteria for Particulate Matter and Sulfur Oxides, External Review Draft includes reference to these documents and summarizes the world literature on the effects of sulfur oxides and particulates on natural vegetation. Although these documents identify certain species as sensitive or very sensitive, the effects of SO_2 and particulates on species in the CB region are experienced only at concentrations much greater than those shown in Table 6.2-14.

Sulfur Dioxide A comprehensive study of the effects of low concentrations of SO_2 on many species that are present on or near the Tract was initiated by Hill and others (1974) in response to the lack of available literature on such effects. The investigators subjected the vegetation of many different plant communities to SO_2 concentrations as low as 0.5 ppm. The study determined that nearly all of the 87 species fumigated were unaffected by short-term exposures of less than 2 ppm (about 5,300 ug/m^3 at 20°C and 1 atm).

Indian ricegrass (*Oryzopsis hymenoides*) is categorized as very sensitive (Hill et al., 1974; Montana, 1979), although Ferenbaugh (1978) has shown that deleterious effects occur only at long-term concentrations greater than 0.13 ppm

(about 350 ug/m^3 at 20°C and 1 atm). This concentration far exceeds anticipated levels of C-b emissions.

A recent study by Thompson et al. (1980) investigated the effects of SO_2 and NO_2 on several species of native desert plants. Low concentrations of SO_2 (0.2 ppm), NO_2 (0.11 ppm), or SO_2 and NO_2 combined (0.1 ppm NO_2 and 0.22 ppm SO_2) produced no significant difference (α=0.05) between growth or dry weight of exposed plants. The concentrations used were much greater than the maximum expected concentrations resulting from CB emissions.

Lichens and bryophytes (mosses and liverworts) are known to be sensitive to air pollution and studies have shown that the foliose and fruticose types are more sensitive to air pollution than crustose lichens. Lichens in the vicinity of CB are crustose types.

Data on the effects of sulfur dioxide on animals are generally derived from laboratory studies, and clear-cut threshold levels for injury or death are not available (Dvorak et al., 1978). Newman (1980) summarized the known effects on wildlife and no studies on the effects of low SO_2 concentrations were reported. Adverse effects of SO_2 on vegetation are not expected, therefore any secondary effect on wildlife through forage consumption is not likely to occur.

Emissions of SO_2 from CB operations are not expected to produce effects in vegetation including lower plants or animals in the vicinity of the Tract.

Nitrogen Dioxide The concentrations of NO_2 required to produce acute injury in vegetation are much greater than SO_2 concentrations (Heck and Brandt, 1977). The pertinent study by Hill et al. (1974) included fumigations of NO_2

from 0.1 to 5 ppm, along with the SO_2 exposures. No evidence of synergistic effects at these ratios was detected. The research by Thompson et al. (1980) do not identify significant synergistic effects at low concentrations of SO_2 and NO_2 combined. The maximum annual average NO_2 concentration, expected at C-b, is only 4 percent of the lowest exposure level used in this study. The EPA Air Quality Criteria for Oxides of Nitrogen, External Review Draft (1978) provided threshold curves of the effects of nitrogen dioxide. Concentrations expected from CB emissions are far less than the threshold data discussed. The criteria document contains no reference to effects of the low concentrations on species present in the C-b Tract vicinity. No research results on the effects of low NO_2 concentrations were reported in the summary document by Newman (1980) concerning the effects on wildlife. No effects on vegetation or wildlife are expected from NO_2 emissions from the CB operations.

Particulate Matter Research on the effects of particulate matter on vegetation has been done on the emissions from cement kilns and for soot and coal dust (Montana, 1979). Studies reported were typically on massive concentrations not typical of rural areas. The available information on the effects of low concentration of particulate matter on the vegetation of semi-arid climates is virtually nonexistent. Despite the paucity of research that is directly applicable to the CB Project, there are no indications from other research that vegetation or animals will be adversely affected by the low concentrations of particulate matter anticipated from the operation of the CB facility.

It is possible for trace elements to impact vegetation. However, for the CB Project, arsenic (both gaseous and particulate) and particulate fluoride are below the PSD de minimis levels and are not expected to contribute significant effects.

Carbon Monoxide CO concentration levels expected have no detrimental effects on flora and fauna.

6.2.4.3 Effects on Visibility

Visual range measurements have been taken at the Hunter Creek Station near the C-b Tract since 1975. Mean visual range has been in excess of 70 miles with no apparent change since inception of measurements. Visibility protection can address two aspects of visibility impairment: plume perceptibility (i.e. that due to one or a few sources) or regional haze. Current EPA regulatory requirements address only the former. Furthermore, the subject of plume perceptibility from a regulatory standpoint is most critical near Class I wilderness areas and not in the immediate vicinity of the Tract. In addition, plume opacity is regulated separately under emission source regulations.

The only Class I area in the region that could potentially be impacted is the Flattops Wilderness area administered by the U.S. Forest Service. Integral vistas from the Flattops have not been identified by either the U.S. Forest Service or the State of Colorado. At the closest point, on the wilderness area boundary is 57 km from the C-b facility, on an azimuth 84° from north. Limits of the boundary are from azimuths 66° to 97° from north, and therefore winds from only two sectors, west and west-southwest, have the potential to impact the wilderness area.

A visibility impact analysis has been undertaken utilizing the EPA recommended technique (EPA, 1980). The technique consists of three level screening proceedure. It was determined, at the first level, that CB activities will not have a significant adverse impact on visibility. Thus, the refined analyses of subsequent levels was not warranted.

6.2.4.4 Effects of Dry and Wet Deposition

In its most recent PSD permit application, CB estimated the potential for impacts of acid deposition on AQRV's. Using a technique suggested by EPA that is based on a paper by Fox (1982), it is estimated that there will be 0.5 kg of acid deposition per hectare-year which is approximately 10% of the threshold at which a significant impact is judged to occur.

6.0 ENVIRONMENTAL EFFECTS AND CONTROL PLANS

6.3 Hydrology

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6.3 Hydrology

6.3.1 Activities Affecting Hydrology

6.3.1.1 Introduction

Tract operations have the potential to affect the hydrology of both surface waters and groundwaters.

Land disturbances may affect the natural surface runoff and drainage patterns in the Tract vicinity. Deposition of spent shale in Cottonwood and Sorghum Gulches will significantly alter those two on-Tract drainages. The hydrology of the pile is discussed in this Section and the control of natural drainages around the pile and design of on- and near-Tract structures to control or contain all surface runoff are discussed in Section 6.8, Erosion Control Plan.

One major impact of Tract operations on the hydrologic regime of groundwaters is caused by the mine shafts which extend down through groundwater aquifers; later, portions of mining levels may do likewise. Inflow to the shafts has been experienced; inflow to the mine is expected. This water inflow must be removed (dewatered) from the shafts and mine. The aquifers have been depicted in the stratigraphic concept described in Section 2.3.1.

Historically, the waters derived from dewatering the shafts has exceeded CB water requirements. Thus, a second factor affecting hydrology is the disposal of excess mine water. As full-scale oil production is reached water demand will be in closer in balance with supply. Water supply and demand is discussed in Section 6.3.1.2.

Three methods have been used for disposal of excess mine water: surface discharge, sprinkler irrigation, and reinjection. They are quantitatively discussed in Section 6.3.3.1. In the future excess waters may be used for processed shale moisturizing and cooling as discussed in Section 6.3.3.3.

6.3 Hydrology

Water quality considerations are discussed in Section 6.4.

6.3.1.2 Water Supply and Requirements

6.3.1.2.1 Water Requirements

Expected water requirements for the 14,100 BPCD facility are shown on Figure 3.8-2. A breakdown of maximum water uses is presented in Table 6.3-1. Water consumed for dust control and revegetation will vary seasonally, with little used during the winter. Surplus water will be used for MIS development and any excess will be discharged. It is predicted that the Project will not affect the supplies of holders of senior rights and consequently, additional water will not be required for augmentation.

6.3.1.2.2 Water Supply

The present and anticipated source of water for CB operations is on-Tract groundwater produced in dewatering the mine as it is developed. This groundwater is of industrial quality not suitable for drinking without extensive treatment. Alternative sources of water supply include groundwater developed from resources off-Tract; diversion of surface waters from Willow Creek, Hunter Creek, Piceance Creek, and the White River in accordance with water rights priorities; and diversions from the industry-wide Yellow Jacket Project. The on-site supply is discussed here; the potential off-site sources are discussed in Section 4.6.

It is estimated that as the Mine is developed, about 2350 gallons per minute will be drained from the underground aquifer reservoir. In 1979, Energy Consulting Associates estimated that the amount of groundwater contained in the mining zone under the 5094 acre C-b Tract is between 86,000 acre-feet and 168,000 acre-feet. It is estimated that continuous dewatering at 2350 GPM for 34 years with no allowance for reinjection would reduce the subsurface reservoir by approximately 120,000 - 130,000 acre-feet.

TABLE 6.3-1

Maximum Water Use for 14,100 BPCD Facility

Water Requirement	GPM Stream Day	GPM Calendar Day	Barrels of H_2O to Oil
Retorted Shale Cooling and Moisturizing	350	320	0.78
Other Process Cooling and Evaporation	685	630	1.53
Loss in Oil Upgrading (H_2 Production)	65	60	0.15
Revegetation and Dust Control	70	65	0.16
MIS Process Feed Water	360	330	0.8
TOTAL	1530	1405	3.42

6.0 ENVIRONMENTAL EFFECTS AND CONTROL PLANS

6.3 Hydrology

6.3.2 Regulations

Regulations pertaining to hydrology consist of 1) Lease Environmental Stipulations, 2) National Pollutant Discharge Elimination System (NPDES) permit requirements of the Federal Water Pollution Control Act, and 3) the Conditional Decree of the State Water Court. Additionally, Underground Injection Control (UIC) regulations will be promulgated in the future.

6.3.2.1 Lease Environmental Stipulations

The Lease Environmental Stipulations are summarized in Table 1.3-2, and those pertinent to hydrology include Section 1.C.1, Monitoring of Environmental Data; Section 2.D, Waterbars and Breaks; and Section 14.D, Impoundment of Waters.

6.3.2.2 NPDES Permit

The National Pollutant Discharge Elimination System (NPDES) permit was issued in August 1983. The terms of the permit require weekly monitoring of the quantity of mine water discharged from the site.

6.3.2.3 Conditional Decree

The Conditional Decree of the State Water Court (which assigns CB a 1977 priority date for groundwater) requires CB to maintain the status quo for the holders of senior water rights. By 1985, CB must provide the State Water Court with a plan that predicts the geographical area that could be affected and demonstrates how depletions, should they impact senior rights holders, could be offset.

6.3 Hydrology

The Court retains jurisdiction in this matter throughout the life of the Project and CB is obligated to report the status to the court every four years. Hydrologic monitoring data, including that collected during the mine shaft dewatering and reinjection period and that during future mine operations, will be used as a basis for the 1985 water augmentation plan.

Under this Conditional Decree, CB is required (as of August 1979) to monitor the potentiometric levels in wells, flows of surface streams, flows of springs and seeps, and precipitation at locations within the basin as set forth in Exhibits A and B of that Decree (see Figure 6.3-1 and Table 6.3-2 respectively).

CB is also required to submit a monthly water make and usage report to the State Engineer. A typical report is shown on Table 6.3-3.

6.3.2.4 Underground Injection Control (UIC)

Historically, a permit has not been required for CB's reinjection program.

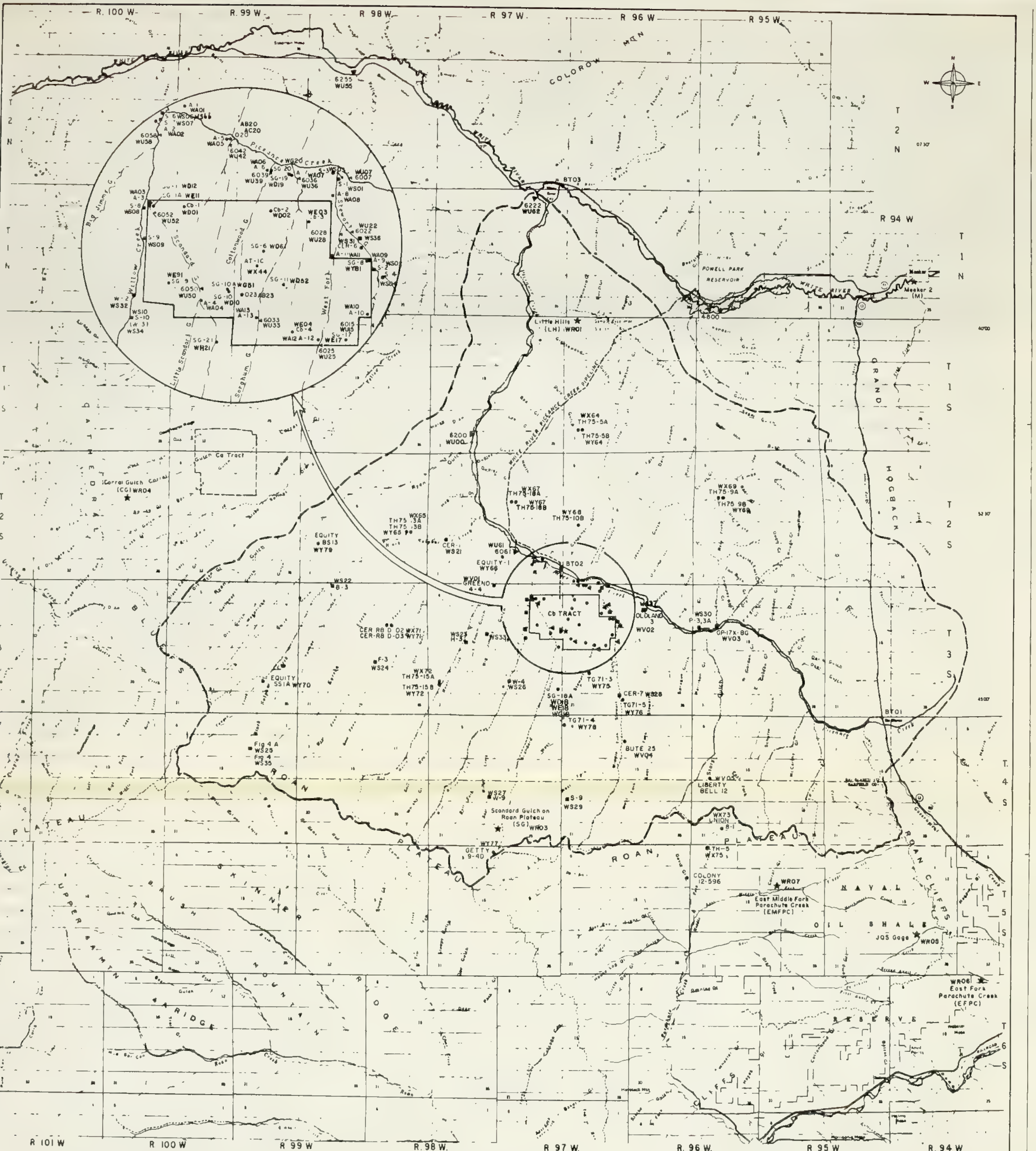
6.3.3 Water Management Plan

The water management program embraces the physical management of water resources and monitoring and analysis to assure continued compliance with regulatory requirements.

6.3.3.1 Water Disposal

Excess mine water has been released through three techniques: surface discharge, land application via sprinkler irrigation, and reinjection.

The water management system utilized through 1982 consists of a series of holding ponds, a reinjection well, a land application system, and discharge to East No Name Gulch. Water from the mine shafts first enters two holding ponds



0 5 Miles

(Base map supplied by the United States Geological Survey)

LEGEND

Symbol	Description
•	Traffic counter stations
◄	Stream gaging station (prefix 0930 omitted from Station No.)
•	Observation well (may have multiple piezometers)
■	Spring or seep
★	Precipitation station
	Paved roads
	Other roads and trails
	Topographic basin of Piceance Creek

NOTES

See Exhibit B for explanation of monitoring station designations, category and normal frequency of measurements, and entities making measurements.

Fig. 6.3-1 EXHIBIT A

KEY FEATURES OF HYDROLOGIC MONITORING PROGRAM FOR Cb TRACT

PICEANCE CREEK BASIN
WATER DIVISION NO 5
STATE OF COLORADO

DECEMBER 1978

OBSERVATION WELLS

Designation	Owner of Well	Data Measured: Piezometric Levels, Upper Aquifer	Data Measured: Piezometric Levels, Lower Aquifer	Data Measured: Water Quality	Measurements By
Cb-1	Cb	—	m	p	A
Cb-2	Cb	m	—	p	A
Cb-3	Cb	m *	m *	p	A
Cb-4	Cb	m	—	p	A
SG-1	Cb	c	c	p	A
SG-1A	Cb	m	—	p	A
SG-6	Cb	m	m	p	A
SG-8	Cb	m	—	p	A
SG-8R	Cb	—	m	p	A
SG-9	Cb	c	c	p	A
SG-10	Cb	—	m	p	A
SG-10A	Cb	m	—	p	A
SG-10R	Cb	—	m	p	A
SG-11	Cb	m	m	p	A
SG-17	Cb	c	c	p	A
SG-18A	Cb	m	—	p	A
SG-19	Cb	c	—	p	A
SG-20	TOSCO	m	—	p	A
SG-21	Cb	m	—	p	A
AT-1C	Cb	m	m	p	A
A-1	+	c	—	p	A
A-2	+	m	—	p	A
A-3	Cb	c	—	p	A
A-4	Cb	m	—	p	A
A-5	Cb	c	—	p	A
A-6	+	m	—	p	A
A-7	Cb	c	—	p	A
A-8	+	c	—	p	A
A-9	Cb	m	—	p	A
A-10	Cb	m	—	p	A
A-11	Cb	c	—	p	A
A-12	Cb	m	—	p	A
A-13	Cb	m	—	p	A
TH75-5A & 5B	U.S.	m (5A)	m (5B)	—	A/F
TH75-13A & 13B	U.S.	m (13A)	m (13B)	—	A/F
Equity 1	Equity Oil Co	—	m	—	A/F
TH75-18A & 18B	U.S.	m (18A)	m (18B)	—	A/F
TH 75-10B	U.S.	—	m	—	A/F
TH75-9A & 9B	U.S.	m (9A)	m (9B)	—	A/F
Equity Sulfur 1A	Equity Oil Co	—	m	—	A/F
CER RB-D-02 & 03	U.S.	m (02)	m (03)	—	A/F
TH75-15A & 15B	U.S.	m (15A)	m (15B)	—	A/F
Greeno 4-4	Shell Oil Co	m *	m *	—	A/F
TG71-3	TOSCO	—	m	—	A/F
TG71-5	TOSCO	—	m	—	A/F
Oldland 3	TOSCO	m *	m *	—	A/F
GP-17X-8G	U.S.	m *	m *	—	A/F
Bute 25	TOSCO	m *	m *	—	A/F
Liberty Bell 12	TOSCO	m *	m *	—	A/F
Union 8-1	Union Oil Co	m	—	—	A
Getty 9-40	Getty Oil Co	—	m	—	A/F
Colony 12-596	Atlantic Richfield	c	—	—	A/Colony
TG71-4	TOSCO	—	m	—	A/F
Equity 8S-13	Equity Oil Co	—	m	—	A/F

An asterisk (*) following frequency symbols in columns under "Piezometric Levels" indicates that the composite piezometric level is monitored

Frequency of measurement of water levels in alluvial wells indicated under "Upper Aquifer"

+ Regardless of ownership, Applicant has the right to monitor these wells

PRECIPITATION

Designation	Name of Station	Measurements: Frequency	Measurements: By
020	Cb Air quality trailer 020	c	A
023	Cb Air quality trailer 023	c	A
LH	Little Hills	c	F
M	Meeker 2	c	F
SG	Scandard Gulch on Roan Plateau	c	F
CG	Corral Gulch	c	F
JQS	JQS Gage	c	F
EFPC	East Fork Parachute Creek	c	F
EMFPC	East Middle Fork Parachute Creek	c	F

STREAM FLOW

(Prefix 0930 omitted from Station No.)

Station No.	Description	Data Measured: Discharge	Data Measured: Quality	Measurements By
4800	White River below Meeker	c	p	F
6007	Piceance Creek below Rio Blanco	c	p	F
6015	Middle Fork Stewart Gulch	c	p	F
6022	Stewart Gulch above West Fork	c	p	F
6025	West Fork Stewart Gulch, upstream	c	p	F
6028	West Fork Stewart Gulch at mouth	c	p	F
6033	Sorghum Gulch, upstream	c	p	F
6036	Sorghum Gulch at mouth	c	p	F
6039	Cottonwood Gulch	c	p	F
6042	Tributary of Piceance Cr (No Name Gulch)	c	p	F
6C45	Piceance Creek below Gardenhire Gulch	c	p	F
6050	Scandard Gulch, upstream	c	p	F
6052	Scandard Gulch at mouth	c	p	F
6058	Willow Creek	c	p	F
6061	Piceance Creek above Hunter Creek	c	p	F
6200	Piceance Creek below Ryan Gulch	c	p	F
6222	Piceance Creek at White River	c	p	F
6255	Yellow Creek near White River	c	p	F

SPRINGS OR SEEPS

Designation	Data Measured: Discharge	Data Measured: Quality	Measurements By
Cb S-1	w	p	S/A
Cb S-2	—	p	A
Cb S-3	w	p	S/A
Cb S-4	—	p	A
Cb S-6	w	p	S/A
Cb S-7	—	p	A
Cb S-8	w	p	A
Cb S-9	w	p	A
Cb S-10 (W-3)	w	p	S/A
CER-1	w	—	S
B-3	w	—	S
H-3	w	—	S
F-3	w	—	S
Fig. 4-A	w	—	S
W-4	w	—	S
W-9	w	—	S
CER-7	w	—	S
S-9	w	—	S
P3 & 3A	w	—	S

GENERAL NOTES

1 See Exhibit A for location of monitoring stations listed on this Exhibit.

2 Letter symbols under columns of "Data Measured" indicate normal frequency of measurements as follows.

- c - continuous recorder (or daily total or mean)
- w - weekly
- m - monthly
- q - quarterly
- s - semiannually
- a - annually
- p - periodic or variable depending on water quality parameters measured

3 Letter symbols under column of "Measurements By" have following meanings:

- A - Applicants in Case No W-3492
- F - Federal (USGS)
- S - State of Colorado (Div of Water Resources)
- O - Others (Indicated where known)

Table 6.3-2 EXHIBIT B

LIST OF STATIONS OF HYDROLOGIC MONITORING PROGRAM FOR C-b TRACT

TK 162

DECEMBER 1976

TABLE 6.3-3

Typical Water Usage Report
(1983 through Month of October)

1983 C-B WATER USAGE (10**6 GALLONS, * =ACRE FEET)

USE	SOURCE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL YTD	TOTAL YRS TD
ALL SHAFTS	GLAND WTR PUMP STA	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		190.6
		0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*		584.9*
*TOTAL ALL SHAFTS		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		190.6
		0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*		584.9*
OFF-TRACT WTR USED POTABLE	TOWN	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		1.1
		0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*		3.3*
*TOTAL OFF-TRACT WTR USED		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		1.1
		0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*		3.3*
TRACT WATER USED BATCH PLNT	24X-25	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		2.5
		0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*		7.6*
CONSTR	PONDS	.01	.02	.02	.00	.00	.00	.00	.00	.00	.01	.00	.00	.05	18.0
		0.03*	0.05*	0.05*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.02*	0.00*	0.00*	.15*	55.3*
CONSTR	24X25	.00	.00	.00	.02	.02	.02	.01	.02	.02	.00	.00	.00	.11	1.8
		0.00*	0.00*	0.00*	0.07*	0.07*	0.07*	0.02*	0.05*	0.05*	0.00*	0.00*	0.00*	.34*	5.4*
DUST CNTL	PONDS	.00	.00	.00	.00	.03	.00	.01	.00	.00	.00	.00	.00	.04	6.7
		0.00*	0.00*	0.00*	0.00*	0.09*	0.00*	0.04*	0.00*	0.00*	0.00*	0.00*	0.00*	.12*	20.5*
EVP & LEAK	POND C	.00	.00	.00	.02	.07	.09	.01	.00	.00	.00	.00	.00	.20	144.8
		0.00*	0.00*	0.00*	0.08*	0.23*	0.28*	0.03*	0.00*	0.00*	0.00*	0.00*	0.00*	.61*	444.5*
NPDES REL	PONDS	20.83	18.17	20.45	19.44	19.95	18.52	17.70	17.16	16.43	16.99	.00	.00	185.63	974.3
		63.91*	55.74*	62.74*	59.64*	61.21*	56.83*	54.30*	52.67*	50.42*	52.13*	0.00*	0.00*	569.59*	2,989.5*
REINJECT	PONDS	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		225.7
		0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*		692.6*
SPR IRRIG	POND C	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		79.1
		0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*		242.6*
*TOTAL TRACT WATER USED		20.84	18.18	20.46	19.49	20.07	18.63	17.73	17.18	16.45	17.00	.00	.00	186.03	1,452.8
		63.94*	55.79*	62.79*	59.79*	61.60*	57.18*	54.39*	52.72*	50.47*	52.15*	0.00*	0.00*	570.83*	4,457.9*
WATER IN STORAGE -	POND A	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.00	.00		
		3.07*	3.07*	3.07*	3.07*	3.07*	3.07*	3.07*	3.07*	3.07*	3.07*	0.00*	0.00*		
-	POND B	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.00	.00		
		0.46*	0.46*	0.46*	0.46*	0.46*	0.46*	0.46*	0.46*	0.46*	0.46*	0.00*	0.00*		
-	POND C	.20	.20	.20	.17	.10	.01	.00	.00	.00	.00	.00	.00		
		0.61*	0.61*	0.61*	0.54*	0.31*	0.03*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*		
*TOTAL WATER IN STORAGE		1.35	1.35	1.35	1.32	1.25	1.16	1.15	1.15	1.15	1.15	.00	.00		
		4.14*	4.14*	4.14*	4.07*	3.84*	3.56*	3.53*	3.53*	3.53*	3.53*	0.00*	0.00*		
WATER PUMPED -	33X-1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		4.3
		0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*		13.3*
-	24X-25	.00	.00	.00	.02	.02	.02	.02	.02	.02	.00	.00	.00	.12	8.1
		0.00*	0.00*	0.00*	0.07*	0.07*	0.07*	0.06*	0.05*	0.05*	0.00*	0.00*	0.00*	.38*	24.7*
-	32X-12	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		5.9
		0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*		18.0*
-	V/E SHAFT	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		678.9
		0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*		2,083.1*
-	PROD & SERV	21.19	18.62	20.83	19.92	19.98	19.10	19.75	18.87	18.19	18.89	.00	.00	195.34	1,008.4
		65.04*	57.14*	63.91*	61.13*	61.31*	58.60*	60.60*	57.91*	55.80*	57.96*	0.00*	0.00*	599.40*	3,094.2*
*TOTAL WATER PUMPED		21.19	18.62	20.83	19.94	20.00	19.12	19.77	18.89	18.20	18.89	.00	.00	195.47	1,705.5
		65.04*	57.14*	63.91*	61.20*	61.38*	58.67*	60.66*	57.96*	55.85*	57.96*	0.00*	0.00*	599.78*	5,233.3*

with a capacity of five acre-feet each, designated A and B. Their functions are primary settling of suspended solids and control of pH level to achieve the water quality level required by the NPDES permit.

From Pond B the water may go directly to approved surface discharge or to another holding pond (Pond C) which is above the grade of Pond B. Pond C has a five acre-feet capacity and serves as a surge pond for the land application system or for reinjection. From Pond C, water can be pumped to both of these systems simultaneously. Water pumped from Pond C to the reinjection system is filtered through a L'eau Claire sand filter to protect the performance of the injection well which is designed to handle 500-600 GPM.

Water sent to the land application system passes directly from Pond C into a sprinkler system. The land application system is currently designed to sprinkle at a rate of 440 GPM over 100 acres on a continuous basis. The system is controlled such to prevent water from being applied beyond the consumptive level of the land and vegetation.

Table 6.3-4 presents a monthly summary of water pumped and used under the alternative modes. The land application system has not been utilized since September 1981, and its future use is not planned. However, it is available if necessary. The reinjection system has not been used since June 1982; it is available for future use, if necessary. Current plans call for continued use of the surface discharge mode.

6.3.3.2 Water Augmentation Plan

Water management not only consists of appropriate disposal of excess mine waters, but also monitoring to detect the effects, if any, of dewatering and disposal on the water table levels and surface flows. The water augmentation plan includes:

TABLE 6.3-4

Water Management Summary

(GPM)

Year	Month	Water Pumped From Mine	Water Used, Stored, Evaporated	Water Treated(1)			
				NPDES Discharges	Sprinkler (Land Application)	Reinjection	Total
1981	January	1,645	341	1,304	-	-	1,304
1981	February	1,663	596	1,067	-	-	1,067
1981	March	1,392	498	754	-	140	894
1981	April	1,122	278	583	-	261	844
1981	May	1,636	466	1,109	-	61	1,170
1981	June	1,221	136	745	48	292	1,085
1981	July	1,582	467	739	339	37	1,115
1981	August	1,550	275	942	326	7	1,275
1981	September	617*	180	293	39	105	437
1981	October	627	184	8	-	435	443
1981	November	660	205	16	-	439	455
1981	December	772	298	-	-	474	474
1982	Janaury	664	181	-	-	483	483
1982	February	651	154	5	-	492	497
1982	March	535	90	-	-	445	445
1982	April	476	60	-	-	416	416
1982	May	663	87	-	-	576	576
1982	June	588	83	-	-	505	505
1982	July	560	20	540	-	-	540
1982	August	562	22	540	-	-	540
1982	September	532	7	525	-	-	525
1982	October	472	0	472	-	-	472
1982	November	460	2	458	-	-	458
1982	December	495	0	495	-	-	495

(*Starting September 1, 1981, the V/E Shaft was no longer pumped and allowed to fill)

(1) Water Pumped = Water Used + Water Treated

1) Monitoring of water levels in wells over extended periods of time;
2) Continued efforts to improve the accuracy and data base of the Regional Groundwater Model developed by the USGS.
3) Releases to surface streams, if required;
4) Reinjection to deep wells, if required;
5) Future water supply and diversion projects as needed to protect senior water rights holders.

6.3.3.3 Processed Shale Pile

The processed shale will be moisturized for cooling and to aid in its compaction. It will receive further hydrologic input from precipitation and irrigation. The pile will reach hydrologic equilibrium through the balance of precipitation, irrigation, infiltration, evaporation, evapotranspiration, and pile outflow (if any). The water balance of the processed shale pile in Cottonwood and Sorghum gulches has been analyzed by Woodward-Clyde Consultants using a simplified unsaturated flow model. This model uses monthly precipitation and evaportranspiration data as inputs. Three phases of pile development were examined: the construction, reclamation, and the post-reclamation periods (see Tables 6.3-5 and 6.3-6). The tables show that the annual precipitation is less than annual evapotranspiration and the net hydrologic effect is that little or no net water will move through the pile. Before vegetation is fully established, outflow could potentially occur at the margins of the pile (where pile depth approaches zero).

6.3.3.4 Monitoring

All phases of the water management are supported by monitoring activities. For example, deep wells and neutron and temperature probes will be used to detect and measure water movement, if any, in the shale pile. Also, water levels in deep and shallow wells are measured to track effects of dewatering and augmentation if warranted. The monitoring program is described in Section 8.5.

TABLE 6.3-5

Summary of Construction Period Water Balance
for Flat Areas of Proposed Processed Shale Disposal Pile*

Sequence Year	Precipitation[1] (inches)	Evaporation[2] (inches)	Runoff[3] (inches)	Water Into Pile[4] (inches)
1	13.92	10.68	0	3.24
2	10.90	10.49	0	0.41
3	13.12	11.26	0	1.86
4	12.19	10.74	0	1.45
5	11.46	10.40	0	1.06
6	11.24	9.20	0	2.04
7	16.21	12.82	0	3.39
8	9.89	8.47	0	1.42
9	11.25	10.75	0	0.05
10	11.03	10.12	0	0.91
11	14.75	11.09	0	3.66
12	10.29	8.60	0	1.69
13	9.67	9.67	0	0.0
14	13.13	10.79	0	2.34
15	14.47	12.23	0	2.24
16	9.45	8.95	0	0.50
17	13.91	12.96	0	0.95
18	12.93	11.42	0	1.51
19	15.54	13.37	0	2.17
20	12.52	11.44	0	1.08
Total[5]	247.87	215.45	0	32.42
Mean[5]	12.39	10.77	0.0	1.62

1) Precipitation falls as rain (no storage of snow is assumed; that is, any snow falling on the surface is assumed to melt rather than accumulate during the winter).

2) Estimated evaporation from pile surface only.

3) Estimated based on a curve number = 10 of the cited reference (0.0 inch per year runoff).

4) Precipitation less evaporation and runoff.

5) 20-year simulation period

* Woodward-Clyde Consultants (1983), Table 9.

TABLE 6.3-6

Summary of Post-Reclamation Water Balance for Proposed Processed Shale Disposal Pile*

Sequence Year	Precipitation (inches)	Evapotranspiration (inches)	Runoff[2] (inches)	Change in Soil Moisture Storage[3] (inches)	Seepage Below 6 Feet (inches)
1	13.92	15.57	0.08	-1.33	0.0
2	10.90	13.20	0.12	-2.42	0.0
3	13.12	12.76	0.01	0.35	0.0
4	12.19	12.23	0.05	-0.09	0.0
5	11.46	11.41	0.01	0.04	0.0
6	11.24	10.92	0.00	0.32	0.0
7	16.21	15.70	0.18	0.33	0.0
8	9.89	10.44	0.00	-0.55	0.0
9	11.25	11.98	0.00	-0.73	0.0
10	11.03	10.50	0.00	0.53	0.0
11	14.75	13.93	0.43	0.39	0.0
12	10.29	10.63	0.05	-0.39	0.0
13	9.67	9.83	0.02	-0.19	0.0
14	13.13	11.90	0.01	1.22	0.0
15	14.47	14.68	0.04	-0.25	0.0
16	9.45	9.80	0.00	-0.35	0.0
17	13.91	13.51	0.05	0.35	0.0
18	12.93	13.91	0.14	-1.12	0.0
19	15.54	14.22	0.11	1.21	0.0
20	12.52	12.34	0.00	0.18	0.0
21	11.72	11.88	0.01	-0.17	0.0
22	13.22	12.22	0.05	0.95	0.0
23	14.00	14.74	0.00	-0.74	0.0
24	10.84	12.18	0.00	-1.34	0.0
25	14.01	13.73	0.05	0.23	0.0
26	12.09	12.97	0.00	-0.88	0.0
27	11.17	10.00	0.00	1.17	0.0
28	12.67	11.86	0.00	0.81	0.0
29	12.66	13.39	0.01	-0.74	0.0
30	13.46	14.12	0.02	-0.68	0.0
Total (30-year)[4]	373.71	376.15	1.44	-3.89	0.0
Mean[4]	12.46	12.54	0.05	-0.13	0.0

1) Represents period from January 1951 through December 1980
2) Runoff curve number = 54 (of cited reference)
3) In upper 6 feet of pile
4) 30-year simulation period
* Woodward-Clyde Consultants (1983), Table 14

6.3.4.1 Cones of Depression

Mine water inflow comes from the shafts and (in the future) from the mining horizon. Grout curtains were constructed in the V/E shaft to reduce major inflows. Water that enters the Mine is removed via the system described in Section 3.3.

Mine dewatering lowers the pressure level of the groundwater in aquifers that have been pierced. This effect is greatest at the Mine and decreases with distance from the Mine; it is termed the cone of depression.

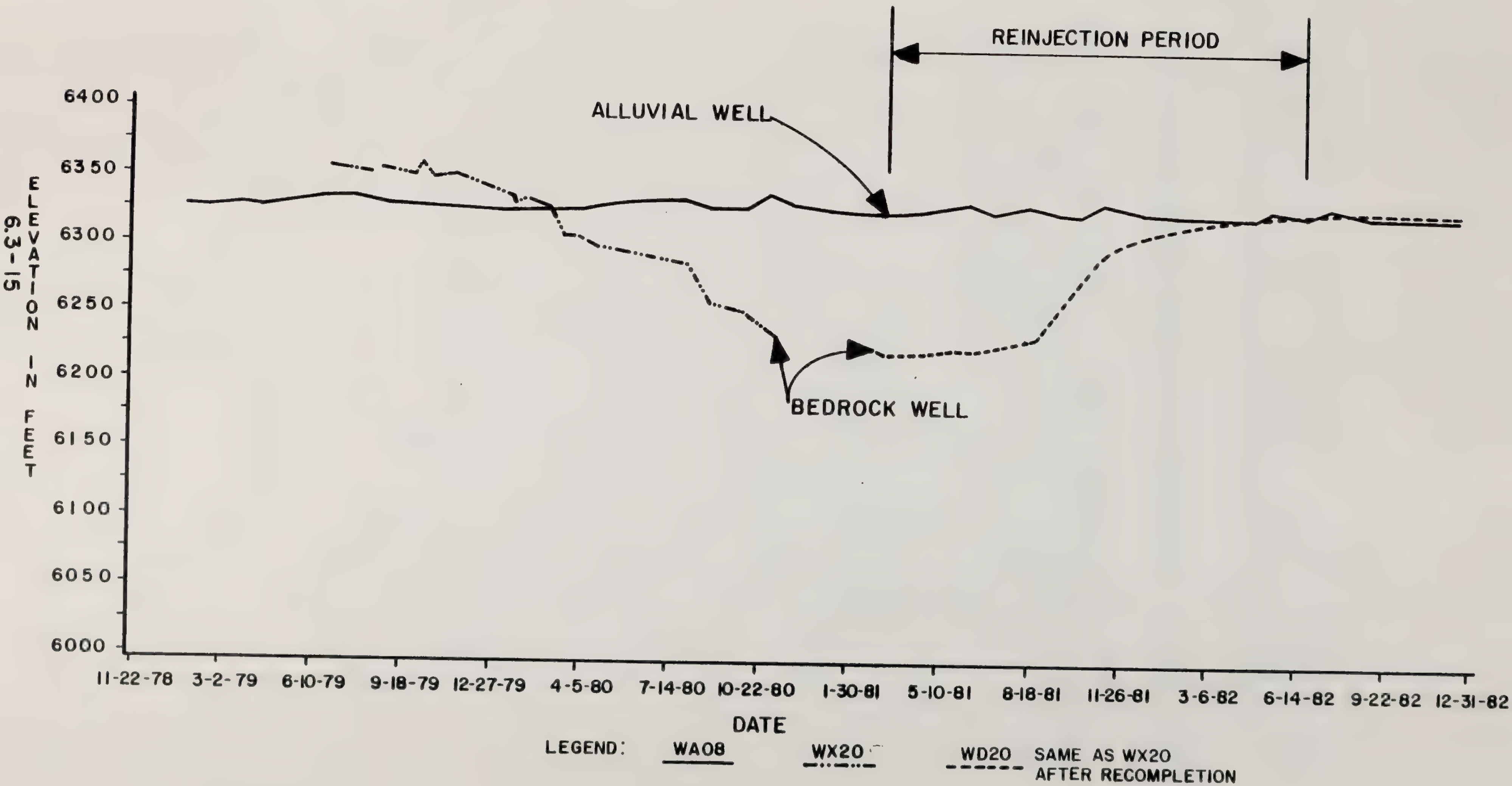
Mining activities have affected several aquifers as discussed in Section 2.3. There is reason to believe that many of these aquifers are separated by impervious strata and therefore are not in hydrologic communication. Where this is true, each affected aquifer has its respective cone of depression.

Data collected over recent years continue to strongly suggest that tight zones of oil shale highly restrict the vertical movement of groundwater between the major hyrologic units. This is supported by several categories of evidence. One such category involves well pairs along Piceance Creek north of the Tract and in lower Willow Creek at the northern corner of the Tract. Each well pair consists of a deep bedrock well and an alluvial well within close proximity. As shown in Figure 6.3-2, the depressurizing effects which have been detected and measured in the deep bedrock wells have not been observed to date in the alluvial companions; thus, there is no evidence to date from these wells that the deep bedrock aquifers and the alluvial deposits in the stream valleys are hydrogically connected.

Other categories of evidence that support these interpretations include water chemistry, drill stem tests in the deep wells, observations within the shafts during construction, and age dating by radiocarbon usage.

FIGURE 6.3-2

COMPARISION OF WATER LEVELS
IN C-b WELL PAIR DURING SHAFT DEVELOPMENT



Monitoring to date has shown that water levels in wells off-site have not been significantly affected by dewatering. Should any effects be detected the mitigation elements of the water augmentation program will be implemented.

6.3.4.2 Effects of the Cone of Depression on Soils, Vegetation, and Wildlife

Because of the evidence that the deep aquifers are not hydrologically connected to any specific degree with the alluvial aquifers, dewatering effects are not expected to be transmitted to the surface; consequently, effects on soil, vegetation, and wildlife are not expected.

6.0 ENVIRONMENTAL EFFECTS AND CONTROL PLANS

6.4 <u>Water Quality</u>

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6.0 ENVIRONMENTAL EFFECTS AND CONTROL PLANS

6.4 Water Quality

This plan has been prepared to evaluate activities which may affect quality of water resources, to review applicable laws and regulations, to set forth procedures which will be followed to assure compliance with appropriate requirements and to delineate mitigated environmental effects.

6.4.1 Activities Affecting Water Quality

Many elements of the proposed Project have the potential to affect the quality of nearby water resources. The major activities and facilities proposed that could affect water quality are: 1) construction, 2) mining, 3) processing facilities, 4) shale piles and 5) on-Tract product storage, and 6) abandonment. These are described in the following subsection.

Land surface modifications associated with construction and operation could change the stream sediment load. Groundwater produced by dewatering the shafts and development mining, if released without appropriate control, could degrade stream water quality. Likewise, uncontrolled effluents from the mine and plant facilities could cause stream pollution. Uncontrolled runoff from the raw shale stockpile and processed shale disposal area has the potential to contaminate surface water and shallow groundwater. Uncontrolled shale moisturizing techniques have the potential to cause leaching through the processed shale pile.

6.4.2 Regulations and Permits

6.4.2.1 Lease Requirements

Section 11 of the Lease and Section 9 of the Lease Environmental Stipulations for Tract C-b require that the Lessee carry out all operations on the Tract in compliance with federal, state and local laws and regulations. The Project will be subject to a number of water quality laws as described below.

6.4 Water Quality

6.4.2.2 Federal Laws and Regulations

Numerous federal laws and regulations deal in some way with water quality control. The Federal Water Pollution Control Act (FWPCA), its amendments and regulations adopted by EPA under its provisions require 1) the preparation and implementation of oil spill contingency plans for storage tanks and pipelines and 2) a National Pollutant Discharge Elimination System (NPDES) permit for effluents leaving the plant. Discharges of excess mine waters are subject to the requirements of the NPDES. The spill contingency plan for oil and hazardous materials is addressed in Section 6.6.

Sections 208 and 106 of the Clean Water Act (CWA) relate to the protection of groundwater. The Safe Drinking Water Act (SDWA), through its underground injection control and sole aquifer protection provisions, and the Resource Conservation and Recovery Act (RCRA) provide for control of certain hazardous practices and protection of highly vulnerable areas. Other EPA statutes that regulate toxic substances and pesticides apply as well. Hazardous wastes are discussed in Section 6.7. Additionally, the Colorado River Basin Salinity Control Act limits salinity of the Colorado River by regulation of discharges to tributary water systems.

Prior to the ignition of the first MIS retort, an Underground Injection Control permit may be required from EPA in accordance with 40 CFR 122.30 or from a future state regulatory program. However, an MIS retort does not fit EPA UIC classifications I through IV and therefore defaults to a Class V well. The operation of MIS retorts does not necessarily include the injection of any type of waste into the retort for purpose of disposal. The fluids injected into MIS retorts are for the purpose of controlling the retorts and improving their retorting efficiency. Therefore permit requirements are somewhat uncertain at this time.

6.4 Water Quality

6.4.2.3 State Laws and Regulations

The Colorado Water Quality Control Act (CWQCA) and regulations thereunder establish stream water quality standards and discharge criteria for pollutants. The Act is administered by the Water Quality Control Division (WQCD) of the Colorado Department of Health. This division also administers the NPDES permit programs by agreement with EPA.

The Division and the Colorado Water Quality Control Commission (CWQCC) administer and regulate the reinjection of water into underground disposal wells, as well as underground disposal of wastes. Any proposal to reinject water or dispose of wastes underground requires public hearings and the approval of the Commission.

Provisions of the Consent Decree of the State Water Court (leading to the CB Water Augmentation Plan, as discussed in Section 6.3.2) require monitoring of water quality in streams, springs and wells.

6.4.2.3.1 NPDES Permit

Cathedral Bluffs was issued an NPDES permit to discharge mine water into Piceance Creek. The permit was reviewed and issued in March 1979 by the WQCD under the authority of the federal CWA and the CWQCA. CB sub- sequently filed an adjudicatory hearing request to address several of the provisions of the permit. The expiration date of the challenged permit was December 31, 1982, and a renewal with amendments submitted in June 1982 has been approved by the WQCD. This permit was received August 31, 1983; it was effective September 30, 1983.

CB must monitor and report the effluent parameters shown in Table 6.4-1 to demonstrate compliance with the effluent limitations in the permit. These measurements are made at the point of discharge of the treated mine drainage

TABLE 6.4-1

Effluent Limitations for 1979 and 1983 NPDES Permits

(Outfall 002, Ponds B or C)

	Maximum Concentration (mg/1)			
	1979 Permit		1983 Permit(3)	
Effluent Parameter	30-day Average	Daily Maximum	30-day Average	Daily Maximum
Flow (mgd)	N/A	(1)	N/A	N/A
Total suspended solids	30	45	30	45
Total dissolved solids	1,200	1,800	1,700	2,500
Total fluoride	N/A	9.0	N/A	N/A
Total boron	N/A	3.5	2.0	3.0
Total ammonia as nitrogen	N/A	1.3	2.4	N/A(2)
Total residual chlorine	N/A	N/A	N/A	N/A
Total phenol	N/A	0.2	N/A	N/A
Soluable aluminum	N/A	1.1	N/A	N/A
Total iron	3.5	7.0	11.0	22.0
Total cadmium	N/A	N/A	0.05	0.10
Total copper	N/A	0.24	0.04	0.08
Total mercury	N/A	0.00005	0.00005	0.0001
Total silver	N/A	0.00005	0.00053	0.0011
Total zinc	N/A	N/A	N/A	N/A

Oil and grease shall not exceed 10 mg/1 in any grab sample nor shall there be a visible sheen. The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units. There shall be no discharge of floating solids or visible foam in other than trace amounts.

(1) The combined flow of all discharges shall not exceed one-tenth of Piceance Creek for the same day as measured at the USGS Gauging Station 09306061.

(2) Weekly max 3.6

(3) Permit received August 31, 1983; effective September 30, 1983

water. All measurements are summarized in a monthly report to the WQCD and EPA. Additional monitoring of the discharge is conducted every six months.

6.4.2.3.2 Piceance Creek Classification and Stream Standards

In 1983 the CWCC classified Piceance Creek and adopted stream standards for its various reaches. The reach of Piceance Creek near the Tract (between Stewart Gulch on the east and Hunter Creek on the west) has been classified: Class II, Aquatic Life Warm Water and Class II, Recreation and Agricultural. Associated stream standards are delineated in Table 6.4-2.

6.4.3 Effluent Sources and Control Plans

6.4.3.1 Disposal of Excess Mine Water

The disposal of excess mine water can be accomplished through three means: pond storage and discharge, land application (sprinkling) and reinjection. These systems are described in Section 6.3.3.1.

6.4.3.2 Processed Shale Pile

Process water will be treated and recycled to meet various on-site water requirements. The water will also be used in spent shale cooling. It may contain AGR deasher effluent, MIS retort waters, cooling tower blowdown, or mine water. The spent shale mix will contain raw shale fines, FGD sludge and OUG spent caustic.

The processed shale will normally contain relatively high concentrations of soluble salts. Depending upon the retorting conditions, the shale may contain soluble sodium oxides, slightly soluble calcium and magnesium oxides, and trace

TABLE 6.4-2

Piceance Creek Stream Standards

Reach: Between Stewart and Hunter Creeks in zone containing outfall 002 from East No Name Gulch.

Classification: Class II Warm Water Aquatic Life
Class II Recreation and Agricultural

Units: mg/1, except where noted

Physical and biological standards:

DO - 5.0
pH - 6.5 - 9.0
Fecal coliform - 2000 per 100 ml

Inorganic Standards:

NH_3 - 0.1 un-ionized
Residual Cl_2 - 0.003
Cyanide (free) - 0.005
S as H_2S - 0.002 undissociated
Boron - 4.0
Nitrite - 0.5

Metals:

Mercury - 0.00005	Arsenic - 0.05
Nickel - 0.2	Cadmium - 0.05
Selenium - 0.05	Chromium - (total) 0.1
Silver - 0.00053	Chromium - (hex) 0.025
Zinc - 0.6	Copper - 0.04
Iron (total) - 11.0	Lead - 0.10
	Manganese - 1.0

elements which are not volatilized during retorting. To prevent contamination of the water resources by these constituents, the runoff and leachate from the processed shale pile will be isolated to the extent possible from natural groundwater and surface water systems.

Hydrology of the processed shale pile was discussed in Section 6.3. As indicated there, average annual precipitation is lower than evaporation and evapotranspiration so that water buildup in the pile will occur only during construction and reclamation of the pile. Water balance modeling indicates that the potential for outflow from the pile will exist only at the margins of the pile (where pile depth approaches zero) and only before vegetation is established. However, the control plan involves:

1) long-term monitoring of the pile by a series of deep wells and thermal logs,

2) runoff diversion structures around the head and toe of the pile as discussed in Section 6.8, and

3) collection of leachate, if any, near the downstream base of the pile and containment in a suitably designed catchment basin.

6.4.3.3 Spent MIS Retorts

Based on current data and analyses of the geology, hydrology and quality of groundwater underlying Tract C-b, the leaching of abandoned MIS retorts is not thought to have a significant effect on groundwater or surface water quality (see Section 6.4.4.3). The control plan involves the following four items:

1) The normal retort quenching operations will occur. Water quality analyses of the quench waters will be conducted on a regular basis

(both input and output from the retorts). Monitoring of retort effluent drainage, if any, will continue after quenching post operations are completed.

Utilization of process water for quenching of MIS retorts will require additional investigation and research to determine its potential specific impacts on groundwater quality and application of additional permitting requirements.

2) Monitoring and analyses of surface water and groundwater hydrologic data will be undertaken in conformance with the Lease and applicable permits as indicated in Section 8.5. In particular, cross reference is made to the 84 bedrock well-string network shown on Figures 8.5-9 to -11, whose status and sampling schedule is given on Table 8.5-4 and whose water quality parameter list is given on Table 8.5-7. This bedrock well network has been superimposed on the mine plan layout (Figure 3.3-2); the composite is Figure 6.4-1 which also indicates the retorting sequence of the first 5 retorts (as 1A, 2B, 2A, 3C, 3B). Steady-state retorting is reached in June 1989 with the ignition of the 4th retort, 3C. Note that retorts nearest the center of the Tract are ignited first.

3) On a "systems-dependent" basis, decreases in water levels or changes in water quality of sufficient magnitude at the innermost rings of monitoring wells may trigger a more frequent sampling, or installation of additional sampling stations or both.

4) Groundwater quality changes, if any, resulting from MIS retort operations and related horizontal migrational rates will be assessed and monitored and the time required for these effects to reach the Tract boundary projected.

5) A program will be executed that will address post-abandonment measures for mitigation of impact from spent AGR shale and abandoned MIS retorts. This effort will be composed of the major elements: 2) analyses and projection of post-abandonment groundwater flow patterns 2) definition of AGR and MIS shale leaching characteristics and 3) evaluation of alternative measures for controlling off-site transport of leachable constituents.

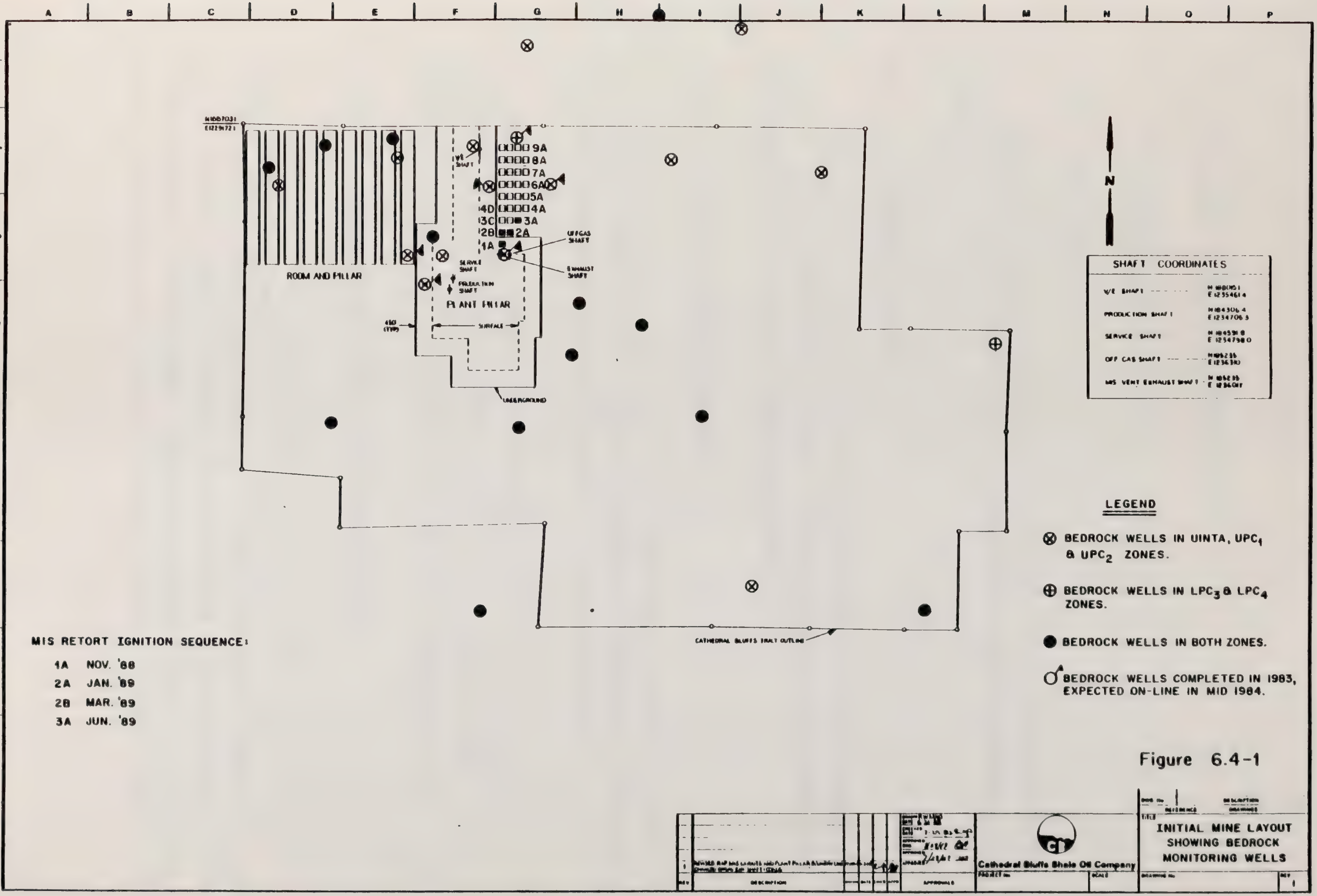

ROOM AND PILLAR
PLANT PILLAR
SERVICE SHAFT
PRODUCTION SHAFT
OFFGAS SHAFT
EXHAUST SHAFT
V/E SHAFT
SURFACE
UNDERGROUND
CATHEDRAL BLUFFS TRACT OUTLINE
9A
8A
7A
6A
5A
4D 4A
3C 3A
2B 2A
1A
N
SHAFT COORDINATES
V/E SHAFT
PRODUCTION SHAFT
SERVICE SHAFT
OFF GAS SHAFT
MIS VENT EXHAUST SHAFT
LEGEND
BEDROCK WELLS IN UINTA, UPC1 & UPC2 ZONES.
BEDROCK WELLS IN LPC3 & LPC4 ZONES.
BEDROCK WELLS IN BOTH ZONES.
BEDROCK WELLS COMPLETED IN 1983, EXPECTED ON-LINE IN MID 1984.
MIS RETORT IGNITION SEQUENCE:
1A NOV. '88
2A JAN. '89
2B MAR. '89
3A JUN. '89
Cathedral Bluffs Shale Oil Company
INITIAL MINE LAYOUT SHOWING BEDROCK MONITORING WELLS

Figure 6.4-1

6.4 Water Quality

6.4.3.4 Plant Runoff

Runoff from the Plant area including the shops, work areas, and process facilities will be collected in the oily/storm water system and treated (see Section 3.8.6).

6.4.4 Environmental Effects

The quality of waters nearby the Tract could potentially be affected by the disposal of excess mine waters, disposal of process waters and effluents, and processed shale leachates above and below ground.

6.4.4.1 Disposal of Excess Mine Waters

Excess mine waters are disposed of by pond storage followed by direct discharge under NPDES permit, sprinkler irrigation or reinjection. The current mode and planned primary method of disposal is direct discharge.

NPDES permit limitations are presented in Section 6.4.2.2. Typical characteristics of mine water appear in Table 6.4-3. The quality of the discharge is within permit limits designed to protect the environment. Any effects of the effluent are expected to be nominal if detectable at all.

6.4.4.1.1 Effects on Water Quality of Piceance Creek

Figures 6.4-2 and 6.4-3 show time histories of fluoride and specific conductance in the discharge and upstream and downstream of the discharge. Levels of water quality constituents at the downstream station depend on 1) those at the upstream station, 2) dilution of the discharge by the stream and 3) levels of constituents in the discharge. Downstream concentrations of fluoride have never exceeded 5 mg/l, and long term averages have been less than 2 mg/l. These

TABLE 6.4-3

Typical Characteristics of Mine Dewatering Effluent from Treatment Ponds

Parameter	Average Concentration (mg/l)
Total Suspended Solids	< 10
Total Dissolved Solids	1375
Fluoride, Total (As F)	27.0
Boron, Total (As B)	1.4
Nitrogen, Ammonia, Total (As N)	0.4
Chlorine, Total Residual	NA
Phenols	< 0.01
Aluminum, Dissolved (As Al)	< 0.1
Iron, Total (As Fe)	0.06
Oil and Grease, Visual	0
Oil and Grease, Total	<10
pH, Field	-
Cadmium, Total (As Cd)	< 0.02
Copper, Total (As Cu)	< 0.02
Mercury, Total (As Hg)	< 0.0002
Silver, Total (As Ag)	< 0.01
Zinc, Total (As Zn)	< 0.02

Source: NPDES Discharge Monitoring Report for July, 1983, Discharge Point 002

Figure 6.4-2

FLUORIDE CONCENTRATIONS (MG/L) IN PICEANCE CREEK
UPSTREAM AND DOWNSTREAM OF THE C-b TRACT AND
IN THE DISCHARGE

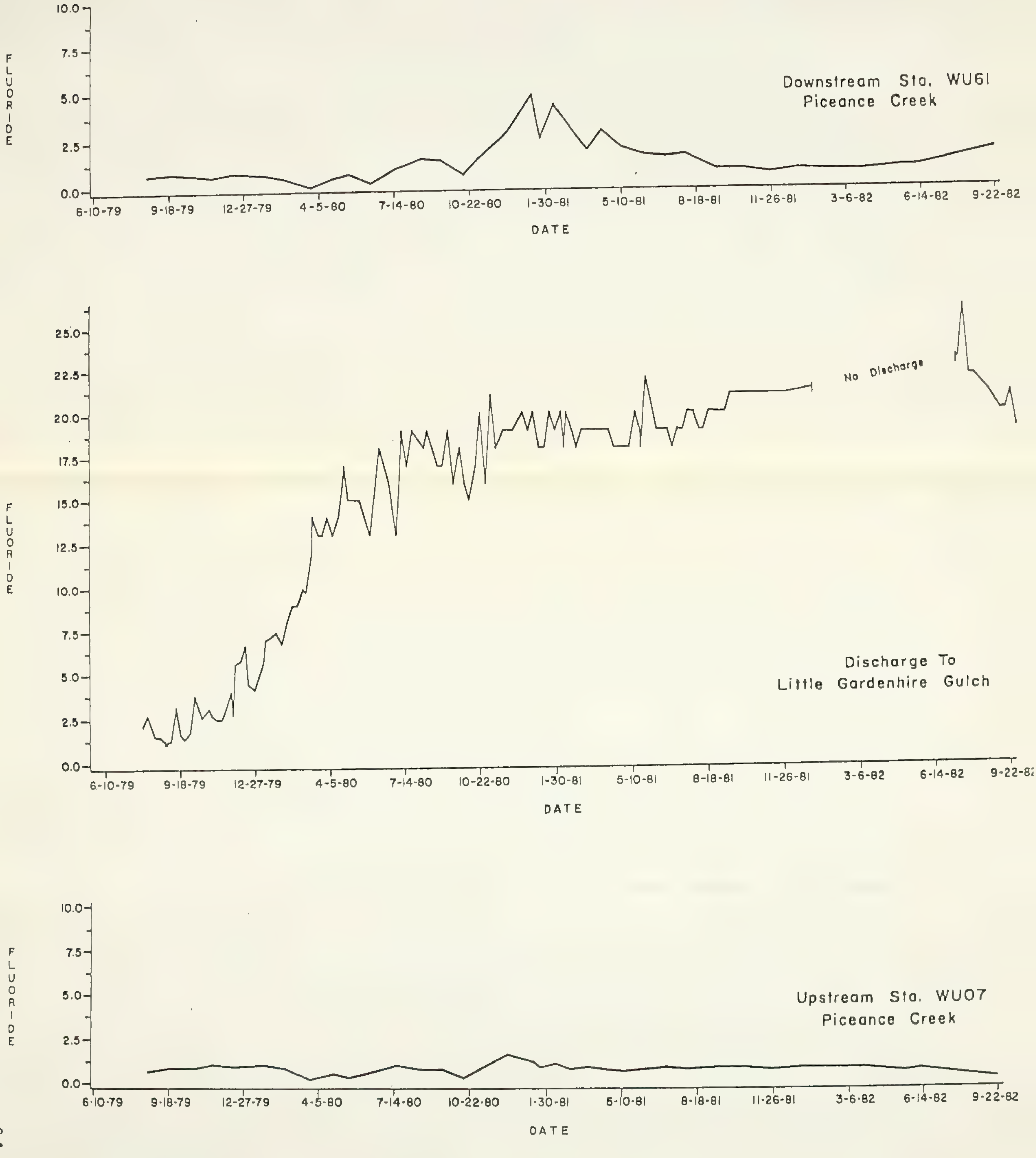
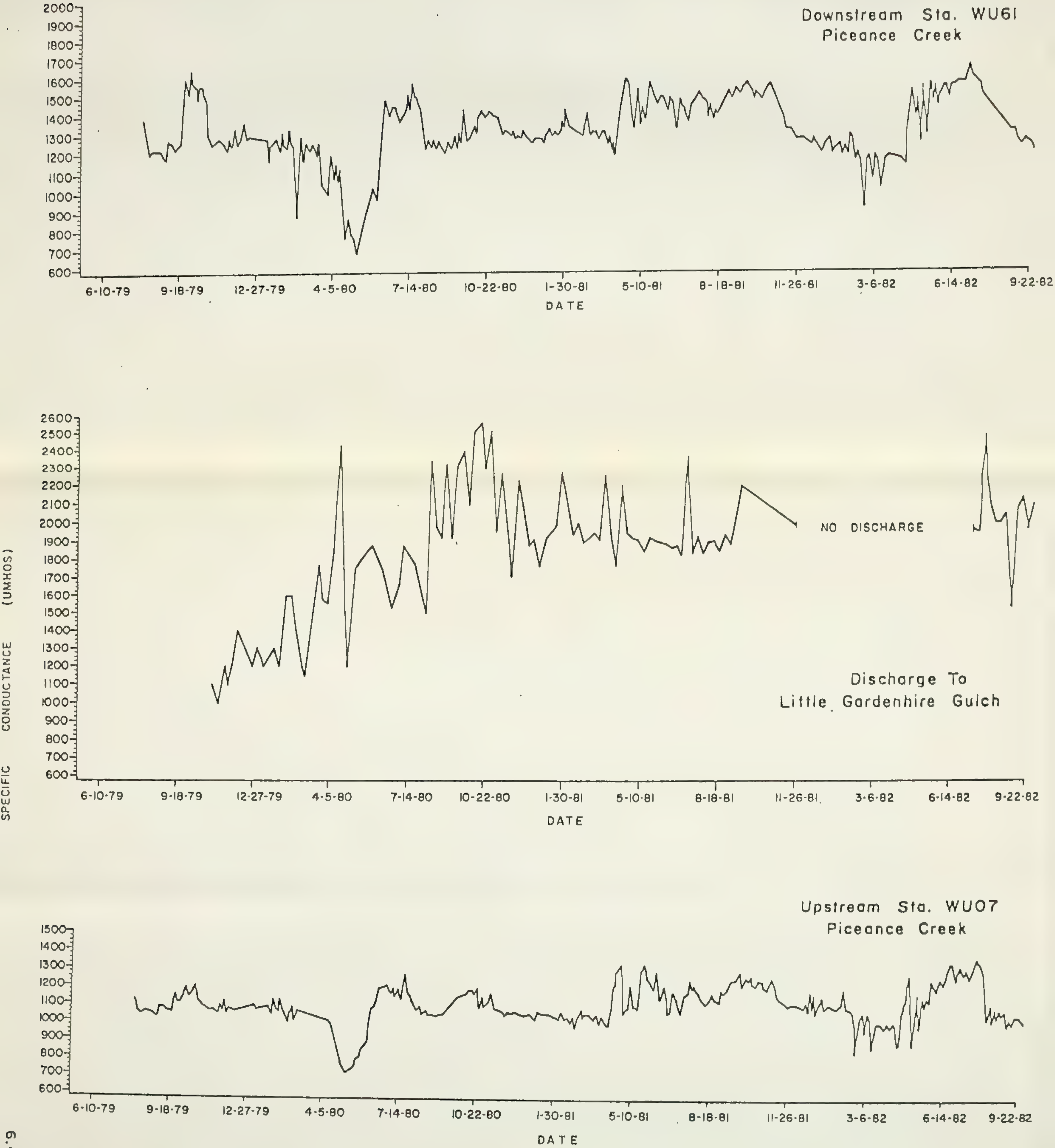


Figure 6.4-3

SPECIFIC CONDUCTANCE (UMHOS) IN PICEANCE CREEK
UPSTREAM AND DOWNSTREAM OF THE C-b TRACT AND IN THE DISCHARGE



levels pose no livestock watering problems. This long-term level is consistent with both the agricultural/ livestock criterion for fluoride of Table 2.3-2. As indicated in Table 6.4-2 there are no stream standards for fluoride in the near-Tract reach of Piceance Creek.

6.4.4.1.2 Effects on Aquatic Ecology

Effects of NPDES discharge on aquatic ecology in Piceance Creek depend on both the ratio of the quantity of discharge to the receiving waters of Piceance Creek and the concentrations of the constituents of the discharge. Other factors that complicate the identification of the potential effects of CB include irrigation on Piceance Creek ranches, cattle grazing, and neighboring springs.

The aquatic studies have shown that development activities on C-b Tract have not had any discernable impacts on the Piceance Creek aquatic system. Both control and developmental stations have shown an increase in siltation, which is causing a change in the dominance of certain orders of macroinvertibrates. Analyses of periphyton data has also shown significant differences between stations; however, no definite trend relating the differences of the control station (Stewart) to the station downstream of development activities (Hunter) have been established. Variation in the aquatic data observed from early baseline studies (1974) through to the 1983 studies seem to be attributable to agricultural impacts and natural variations.

6.4.4.2 Effects of the Processed Shale Pile

As mentioned in Section 6.4.3.2, the processed shale pile will be designed and managed to minimize leaching. Drainage effluent, if any, will be collected, contained and either treated or disposed of according to existing regulations. Thus, its environmental effects are expected to be minimal.

6.4.4.3 Effects of Spent MIS Retorts on Groundwater

The possibility of additional contamination of the deep bedrock aquifers in the mining zone by processed MIS retorts is a function of the leachability of the retorted shale, the character of the leachate formed, and the transport kinetics of the leachate in the underground zone to which it might migrate. Recent work at Los Alamos Scientific Labratory (Wagner et al., 1981) demonstrates that the risk of groundwater contamination from MIS processed shale remaining underground is greatly reduced by two factors. First, at the high temperatures inherent to the MIS process, the organic residuals of retorted shale are combusted. At moderate retorting temperatures, the alkali metal carbonates present in raw shale are decarbonated to produce oxides which are relatively soluble in water. However, at the higher temperatures and with the longer heating intervals associated with MIS retorting, these oxides react with the quartz minerals (SiO_2) present in the shale to produce silicate minerals which are insoluble in water. This set of reactions works to reduce the solubility of the major components sodium, calcium and magnesium; and minor components such as aluminum, nickel, molybdenum, titanium, and iron.

Second, any local deep bedrock groundwater which might pass through the processed shale will react with leachate trace elements to form compounds which have very low solubility in the alkaline groundwater; they will therefore tend to precipitate out and migrate less. The natural groundwater at C-b contains high levels of bicarbonate, sulfate, hydroxide, calcium, magnesium, and organic carbon; the processed shale is composed predominately of high temperature silicates and small amounts of associated trace elements which are not completely bound up in insoluble minerals after MIS retorting. The natural groundwater chemistry limits the solubility of these trace elements by the formation of insoluble compounds (primarily carbonate, hydroxide, sulfate, and calcium compounds) which precipitate out of the leachate and adhere to the solid mineral formation. These precipitation reactions limit, to various extents, the concentrations of lead, strontium, calcium, barium, lithium, fluoride, vanadium,

boron, arsenic, selenium, titanium, iron, cobalt, aluminum, and nickel. In addition, the concentration of organic carbon is also reduced by precipitation reactions (primarily in the form of calcium salts), as well as by adsorption on the retorted shale.

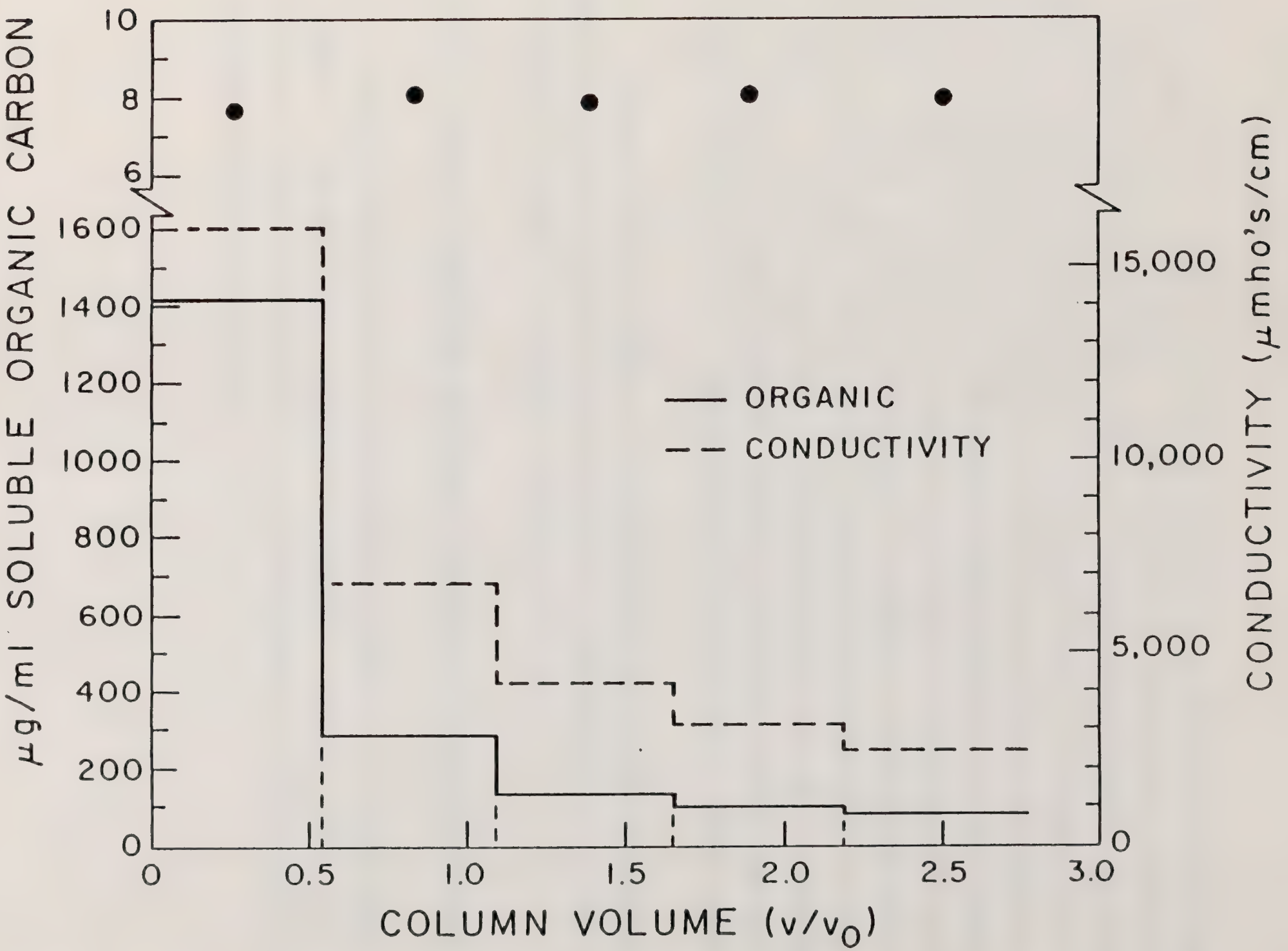
As described earlier, the rate of horizontal movement in the deep bedrock aquifers is extremely slow, and any leachate which might exit processed retorts would only migrate from a few hundreths of a foot to approximately three feet per year. Moreover, during transport, the concentration of any mobile species would be diluted; mobile species would also be subject to such dynamics as diffusion, adsorption and ion exchange, which would further limit their concentrations.

The results of experimental work that investigated the quality of retorted shale leachate vs. time/pore volume of leachate (using Logan Wash Retort 3E processed shale) are shown in Figure 6.4-4. Specific conductivity, total organic carbon and pH levels were measured in the leachate at various pore volume intervals. Both specific conductivity and organic carbon decrease dramatically with the first pore volume of leachate. These results indicate that the majority of the availiable soluble materials are on the surface of the retorted shale and are removed in a pulse in the first pore volume. After this leaching pulse, the concentrations in the leachate are greatly reduced, as a function of the slow rate of diffusion of any additional soluble species in the retorted shale to the surface of the shale particles.

It should be noted that these laboratory experiments utilized retorted shale which had been ground to a fine mesh consistency, thereby increasing the surface area of the retorted shale and the amount of soluble material available for mobilization. In actual field situations, there will be less uniformity of particle size and a greater percentage of large particles, with a corresponding decrease in total surface area and amount of soluble material. However, particle size distribution should not affect the pulsing behavior which has been observed -- that is, the majority of soluble material available for mobilization should still be removed in the first leaching pulse.

FIGURE 6.4-4

LEACHING RATE OF MIS RETORTED SHALE



Source: US DOE, "Environmental Research on a Modified In Situ Oil Shale Process: A Progress Report from the Oil Shale Task Force". DOE/EV-0078 (May 1980).

6.4 Water Quality

Actual field experience from Occidental's MIS operations at Logan Wash confirms this pulsing behavior. Water exiting the bottom of the retorts was analyzed both during and after retorting; concentrations steadily declined after retort shutdown and have returned to background levels. In Figures 6.4-5 and 6.4-6 the concentrations of total dissolved solids and dissolved organic carbon are plotted against time. These figures demonstrate that the small amount of natural seepage into these retorts was sufficient to remove most of the soluble material shortly after retort shutdown. In addition, leachate from Retort 1, which was shut down in 1973, has been analyzed for various water quality parameters. Although this retort has been exposed to only the limited amount of water provided by natural seepage, the data in Table 6.4-4 show that retort effluent water quality was (1983) essentially equivalent to nearby groundwater.

Although evidence indicates that spent MIS retorts will not adversely effect groundwater, CB will continue monitoring and analysis to confirm these preliminary results, as indicated in Section 6.4.3.3.

6.4.4.4 Effects of the Land Application System on Soils, Vegetation and Livestock

The sprinkler irrigation system shown on Figure 6.4-7 was utilized in the summers of 1980 and 1981 to dispose of excess mine waters. During this time vegetation production increased. The irrigated areas have been monitored and continued monitoring is planned.

FIGURE 6.4-5

LEACHING OF TOTAL DISSOLVED SOLIDS OVER TIME
(Logan Wash Retorts 1, 2, 4, 5 and 6)

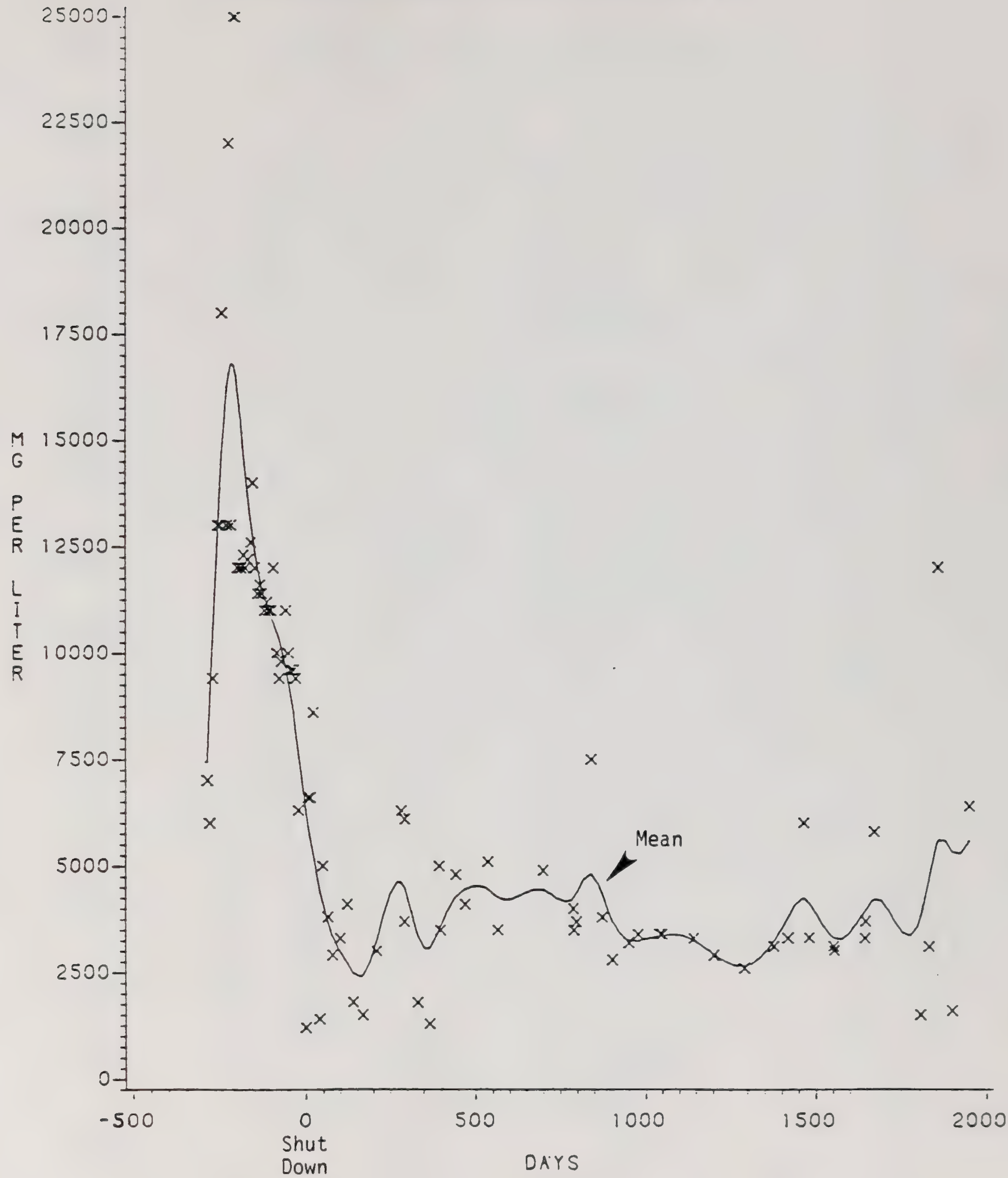


FIGURE 6.4-6

LEACHING OF TOTAL ORGANIC CARBON OVER TIME
(Logan Wash Retorts 1, 2, 4, 5 and 6)

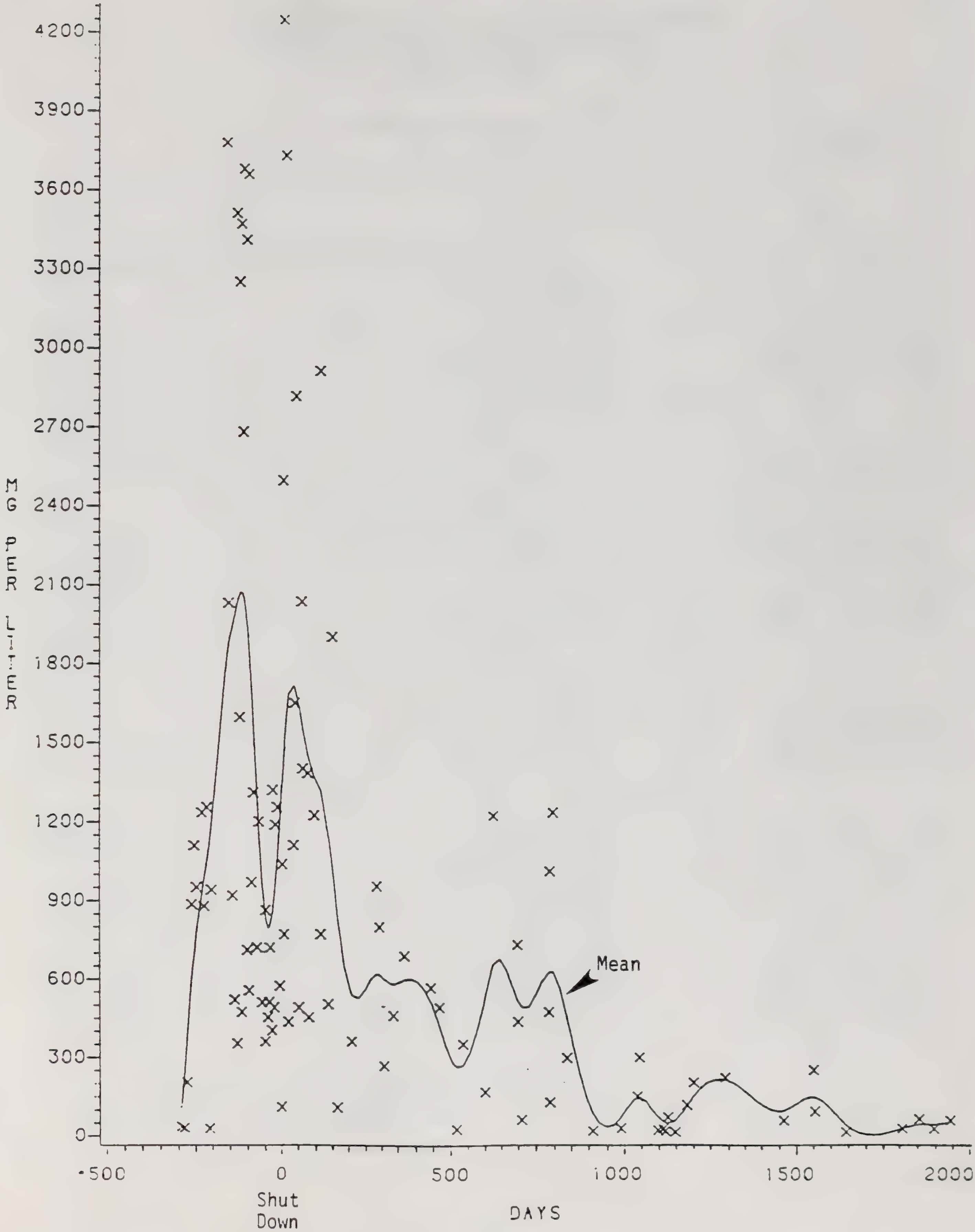


TABLE 6.4-4

Concentrations of Retort 1 Effluent Compared with Logan Wash Background (Aquifer) Concentrations

	Background Aquifers*(mg/l) M ± STD(N)(1)	Retort 1 (mg/l) M ± STD(N)
Arsenic	(2)	(2)
Barium	(2)	(2)
Bicarbonate	806 ± 910 (107)	543 ± 1066 (22)
Boron	11.9 ± 13.0 (106)	4.43 ± 2.07 (20)
Cadmium	(2)	(2)
Calcium	68.1 ± 39.1 (109)	217 ± 101 (20)
Chloride	81.7 ± 80.8 (107)	42.2 ± 40.6 (22)
Chromium	0.11 ± 0.10 (21)	(2)
Copper	(2)	(2)
Fluoride	6.27 ± 6.53 (110)	4.99 ± 3.58 (22)
Iron	(2)	7.62 ± 18.04(19)
Lead	(2)	(2)
Magnesium	53.3 ± 28.0 (110)	194 ± 83.04 (20)
Manganese	7.29 ± 9.23 (34)	1.64 ± 4.48 (20)
Nitrate	(2)	45.99 ± 70.63 (19)
Phenols	0.19 ± 1.16 (143)	0.65 ± 1.08 (21)
Selenium	(2)	(2)
Silver	(2)	(2)
Sodium	551 ± 439 (107)	487 ± 342 (20)
Sulfate	660 ± 440 (106)	2185 ± 1146 (20)
Total Dissolved Solids	2236 ± 1275 (91)	4922 ± 3197 (9)
Aluminum	(2)	(2)
Ammonia	3.01 ± 3.54 (95)	45.4 ± 127 (17)
Lithium	0.45 ± 0.28 (139)	0.9 ± 0.7 (16)
Molybdenum	0.61 ± 0.89 (106)	0.62 ± 0.96 (18)
Nickel	0.09 ± 0.13 (18)	(2)
Organic Carbon, Dissolved	72.3 ± 67.8 (67)	35.8 ± 25.6 (6)
Potassium	5.43 ± 6.58 (107)	252 ± 190 (20)
Strontium	6.17 ± 2.93 (89)	4.75 ± 3.0 (15)
Vanadium	(2)	(2)

(1) Mean ± Standard Deviation (Number of Samples)
 * Wells: LW32, 33, 46, 47, 106, 108
(2) Below instrument detection limit

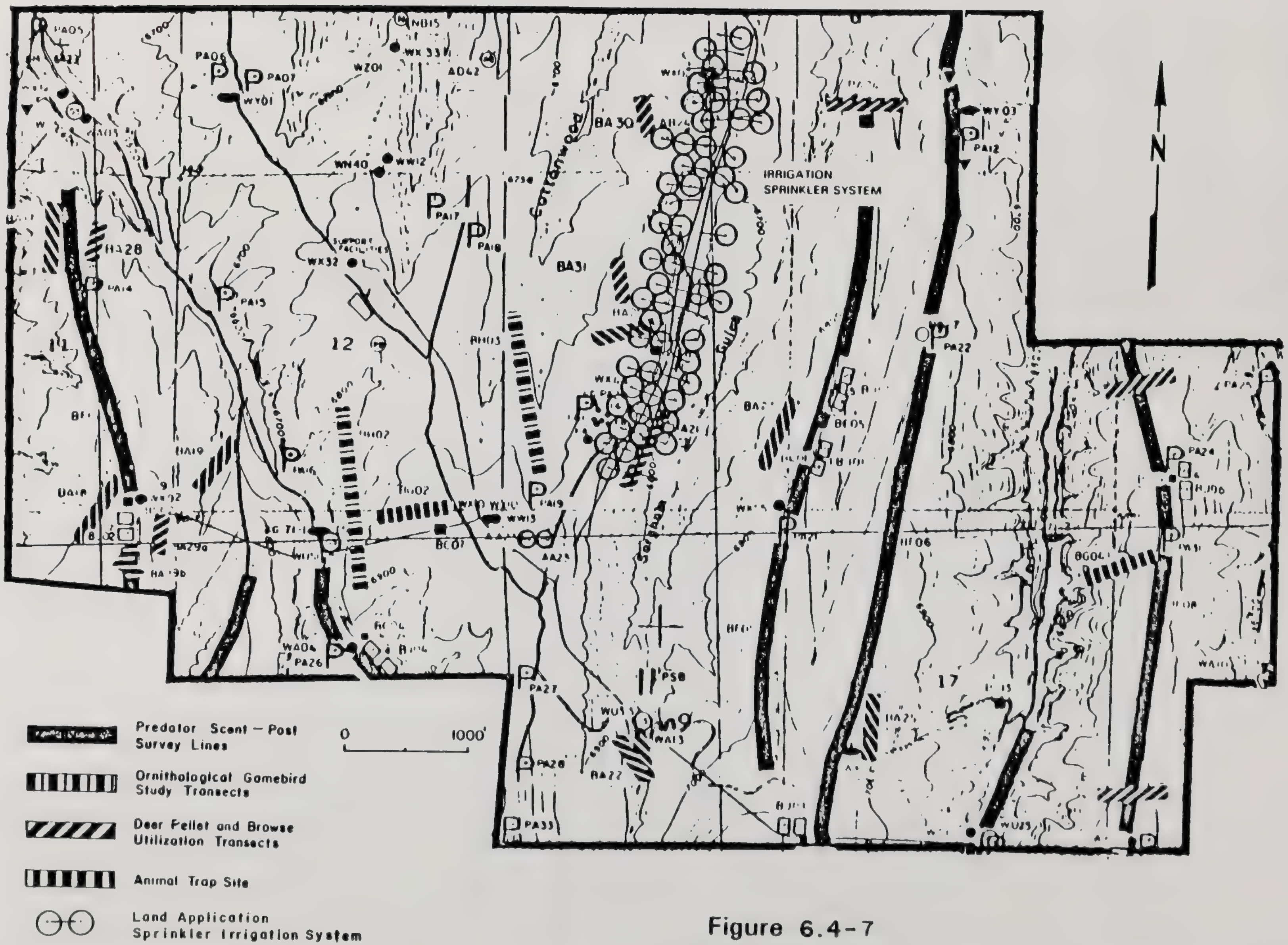


Figure 6.4-7
Biological Network, Showing The Land Application System

6.4 Water Quality

The exchangeable sodium percentage (ESP), electrical conductivity (ECe), pH and boron (B) concentrations were measured in soil samples. Measured ranges were:

Parameters	Irrigated	Control
ESP	<1 - 12.8	1.0 - 1.8
pH	7.3 - 8.7	7.9 - 8.2
ECe	0.4 - 1.9	0.5 - 0.8
B	<0.1 - 1.8	<0.1

Foliar uptake of fluoride, boron and sodium was measured in Western wheatgrass, Indian rice grass and big sagebrush areas. Boron and sodium were below toxic levels. Levels above 60 ppm were reported for fluoride; a toxicosis problem would result if cattle and other fauna continuously fed only on Western wheatgrass with fluoride at this level or greater. However, the fauna that feed on Western wheatgrass are migratory and fluoride levels reduced to 38 ppm by October 1981, one month after irrigation ceased. Sprinkler irrigation was not used in either 1982 or 1983.

6.0 ENVIRONMENTAL EFFECTS AND CONTROL PLANS

6.5 Land Disturbance and Reclamation

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6.5 Land Disturbance and Reclamation

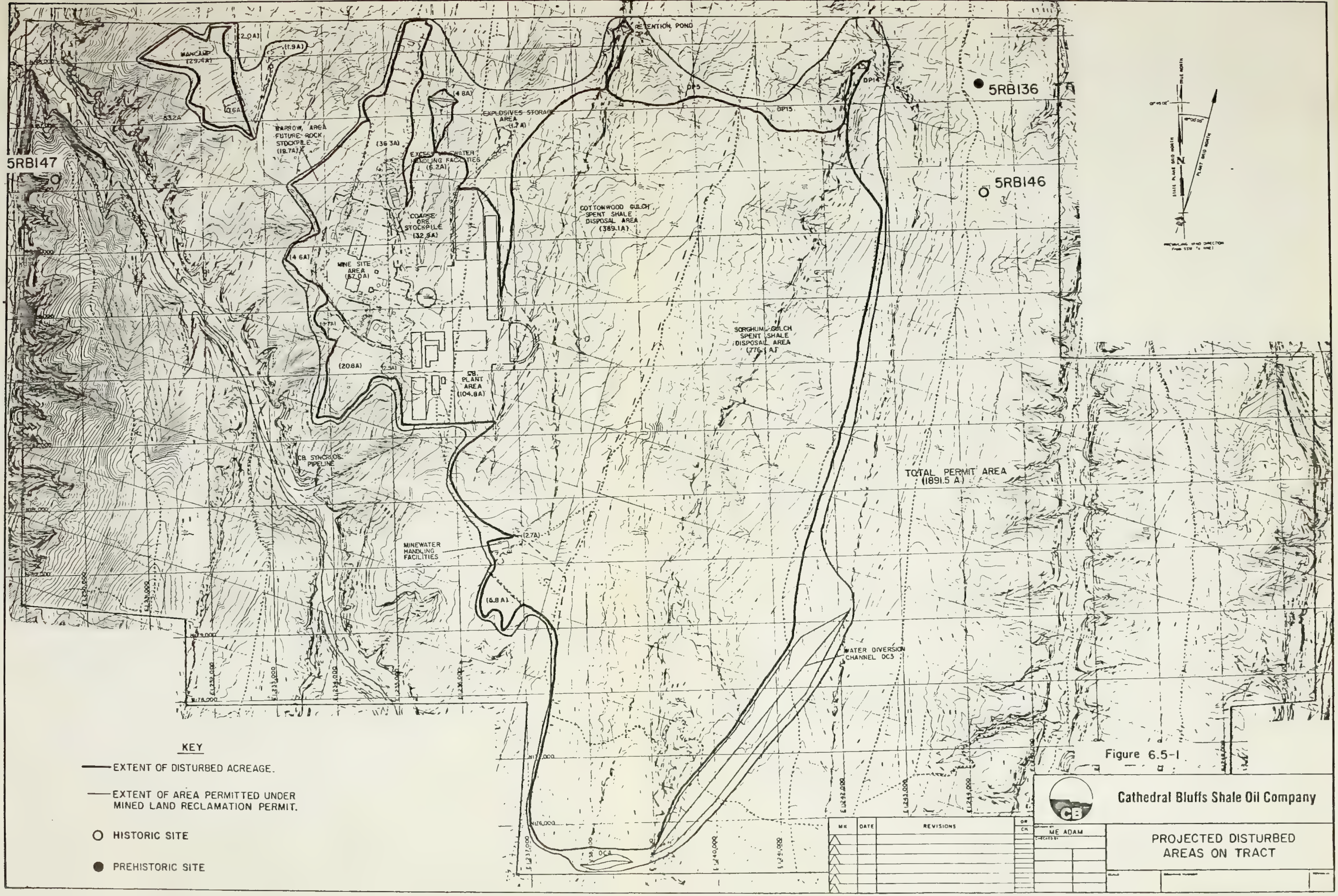
This section addresses expected activities which will have an impact on the land resource of the C-b Tract, the pertinent regulations and permits needed for the implementation of those activities, and a reclamation plan. The reclamation plan was created to meet the specifications contained in those permits and regulations and to mitigate the environmental effects of disturbance. Reclamation of disturbed lands is an important component of the total CB Project. The methodology for implementation of the reclamation plan will continue to be refined during the development of the Tract and as a result of information obtained from test plots, changes in regulatory policies, and advances made in reclamation techniques. For greater detail on the plan, refer to the CB Mined Land Reclamation Plan Permit application to the MLRB.

CB will rehabilitate land disturbed during the development of oil shale resources in a manner consistent with good ecological practices, economic feasibility and practical land use considerations. Processed shale reclamation technology is based on over ten years of staff experience.

Responsibility for planning, design and implementation of the revegetation plan will be shared by CB staff and field personnel who: 1) develop the plan, 2) integrate the plan with other management plans, baseline studies, and current data, 3) coordinate the activities with the Oil Shale Project Office, the Bureau of Land Management, and the Mined Land Reclamation Board, and 4) implement the reclamation plan.

6.5.1 Activities Affecting Land

The activity which will have the major impact on land is the disposal of processed shale. Other activities causing land disturbance include the drilling program (additional core hole sampling and water monitoring wells); construction associated with the plant site, mining, support facilities, and process facilities; access and transport of materials and products; and the temporary storage of raw shale. Refer to Figure 6.5-1.


5RB147
5RB136
5RB146
MANCAMP (29.4A)
(2.0A)
(1.9A)
RETENTION POND
(4.8A)
EXPLOSIVES STORAGE AREA (1.7A)
BARROW AREA FUTURE ROCK STOCKPILE (18.7A)
(36.3A)
EXCESS WATER HANDLING FACILITIES (6.2A)
COARSE ORE STOCKPILE (32.3A)
COTTONWOOD GULCH SPENT SHALE DISPOSAL AREA (389.1A)
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MINE SITE AREA (67.0A)
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C.B. PLANT AREA (104.8A)
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WATER DIVERSION CHANNEL DC3
KEY
EXTENT OF DISTURBED ACREAGE.
EXTENT OF AREA PERMITTED UNDER MINED LAND RECLAMATION PERMIT.
HISTORIC SITE
PREHISTORIC SITE
Figure 6.5-1
Cathedral Bluffs Shale Oil Company
ME ADAM
REVISIONS
PROJECTED DISTURBED AREAS ON TRACT

6.0 ENVIRONMENTAL EFFECTS AND CONTROL PLANS

6.5 Land Disturbance and Reclamation

6.5.2 Regulations and Permits

The Mined Land Reclamation Permit, administered by the Colorado Mined Land Reclamation Board (CMLRB), and the Lease Stipulations for the C-b Tract, administered by the Oil Shale Project Office (OSPO) of the BLM, are the two major regulations and permits affecting land disturbance and reclamation.

6.5.2.1 Lease Requirements

Section 11 of the Lease Environmental Stipulations states that the Lessee shall, in accordance with approved plans, rehabilitate all affected lands to a usable and productive condition, consistent with or equal to pre-existing land uses in the area, and compatible with existing, adjacent undisturbed natural areas. The Lessee is also to leave reclaimed land in a stable, non-hazardous condition such that soil erosion and water pollution are avoided or minimized. The Lease also specifies that the capability to revegetate be demonstrated.

6.5.2.2 Mined Land Reclamation Permit

In 1976, the Colorado Legislature passed HB 1065, the Colorado Mined Land Reclamation Act. The Mined Land Reclamation Board was created and given primary responsibility for implementing HB 1065. All mining operations conducted within the state are now required to have a Mined Land Reclamation Permit. Permit applications must be submitted to, and approved by, the CMLRB. The key item in the application is the reclamation plan. The permit states that reclamation shall be required on all the affected land. The reclamation plan is to include such items as: a description of the type(s) of reclamation of the affected land; and a description of final grading, seeding, fertilization, revegetation, and topsoiling.

On March 28, 1978, the CMLRB approved the permit application of the C-b Shale Oil Venture (now Cathedral Bluffs Shale Oil Company). This permit is a

"Regular Permit" for underground mining for the purpose of recovering shale oil using the MIS retorting process and disposal of raw shale. CB will submit an application for an amendment to this permit to incorporate the use of aboveground retorting and the disposal of processed shale. A copy of the application will be sent to the OSPO for its review and comment. The amendment application will be sent to the CMLRB in 1984.

6.5.3 Disturbance and Reclamation

The reclamation plan will evolve as site development progresses, as regulatory policies change, and as advancements in reclamation methodologies are made. Therefore, the locations, sizes, and timetables for disturbed areas and specific reclamation techniques of the CB Plan may be subject to revisions. The current estimated surface disruption and reclamation schedule appears on Figure 6.5-2.

The reclamation plan described in this section is a revision of the plan approved in the 1976 DDP. It contains elements of the reclamation plan set forth in the present Mined Land Reclamation (MLR) permit and the results of subsequent studies.

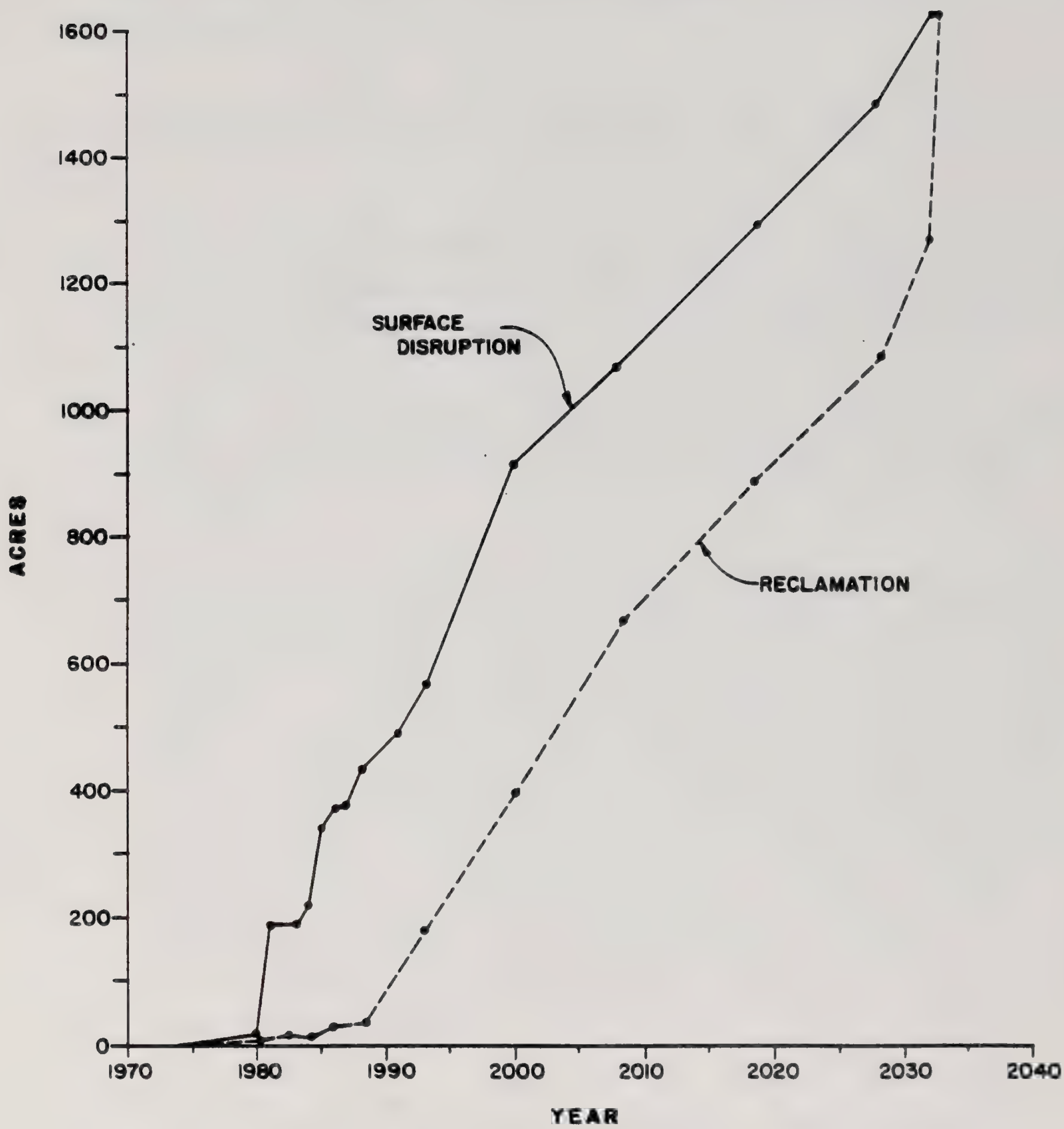
The major objective of the reclamation plan is to return disturbed lands to their former use--rangeland and wildlife habitat. The guidelines presented in this plan apply specifically to the two areas of revegetation: 1) the reestablishment of plant cover on sites disturbed during the exploration and development phases of the Project and 2) revegetation of the processed shale after the retorting operation begins.

6.5.3.1 Reclamation of Disturbed Sites

Major types of sites requiring revegetation of disturbed soils include abandoned drill pads, access and haul roads, mine and plant sites, support facilities, process areas, raw shale storage areas, and other cleared support sites (e.g., temporary laydown areas and mancamp sites). The locations of these

Figure 6.5-2

SURFACE DISRUPTION AND RECLAMATION SCHEDULE



areas and schedules for disturbance are shown in Figures 3.2-1 through 3.2-4. These sites will vary in the length of time they will be in a disturbed state. These time frames will range from less than one year for drill pads to the life of the Project for such sites as the mine development area, process area, support faciliites area, etc.

The disturbance and reclamation strategy for these sites will be as follows:

1) Remove trees (live trunks and limbs over four inches in diameter will be cut to firewood size and stacked) shrubs and slash (to be used as rip rap at the toe of slopes as an erosion control measure).

2) Strip the available topsoil and topsoil-like material for use at sites where disturbance is short-term, or haul it to topsoil a storage pile.

3) Cut and fill disturbed areas to final working grade. While sites are in a disturbed condition and continued activity prohibits final reclamation, temporary stabilization measures - such as covering with asphalt, using at least 50% rock in surface layer, covering with gravel, and spraying with water and chemical dust suppressants - will be used to control erosion. Slopes for these areas will be a maximum of 2:1. Slopes will be seeded with the CB temporary seed mix. Potential erosion will also be controlled by diverting runoff from undisturbed areas around the disturbed sites and channeling runoff from disturbed sites to sediment basins that will be located at the perimeter of the sites.

4) Final reclamation of disturbed sites will commence as soon as possible following the cessation of activity. This will be accomplished by regrading the sites as closely as possible to original contours and replacing the topsoil material.

6.5 Land Disturbance and Reclamation

5) The recontoured sites will be seeded in the fall following topsoil replacement with the approved CB seed mix for disturbed sites and will be mulched with either straw mulch or wood-fiber hydro mulch at the rate of two tons or 1500 pounds per acre, respectively. Transplanting will be performed during the following spring.

6) Fertilizer will be applied to the revegetated areas prior to the third growing season.

7) Areas that are larger than one acre will be fenced to eliminate cattle grazing until vegetation is established (about five years).

8) Stockpiled topsoil will be revegetated, mulched, and fenced.

6.5.3.2 Reclamation of the Processed Shale Disposal Site

The disposal and reclamation plan for the processed shale, produced over the life of the Project, will address a variety of geotechnical, hydrological and environmental considerations.

6.5.3.2.1 Test Plot

CB will test the reclamation plan described below before full-scale implementation occurs. The test plot will be large scale to best simulate the ultimate configuration: perhaps 4 to 5 acres and 25 to 30 feet in depth. The pile will be comprised of Union B processed shale and constructed in the same manner as specified in Section 3.4.5.

To facilitate analysis of hydrology and water quality the test pile will be underlain with an impervious synthetic liner. A monitoring program will be initiated to detect and measure 1) water movement in the pile, 2) changes in characteristics of spent shale over time at different depths, 3) chemical constituents in vegetation, and 4) formation and migration of leachates.

6.5 Land Disturbance and Reclamation

Different reclamation techniques will be tested. They may include 1) mulching, fertilizing, and minimal irrigation, 2) heavy irrigation to leach salts from the rooting zone prior to covering with topsoil, and 3) constructing a capillary barrier (of various test materials) prior to covering with topsoil. In addition, tests will be performed on seeding rates and mixtures, mulch and mulching rates, and so forth.

Successful reclamation of Unishale B retorted shale has been demonstrated (see Table 6.5-1). Colorado State University researchers have conducted revegetation studies at the Union Oil Shale plant site approximately 15 miles southwest of the C-b Tract. Demonstration plots on C-b have used, and will utilize, present and future revegetation technology to assure successful reclamation of the disposal embankment.

6.5.3.2.2 Processed Shale Disposal

The proposed method for constructing the processed shale pile is described in Section 3.4.5.

6.5.3.2.3 Surface Water Drainage

Surface water drainage from the processed shale pile will be controlled in the manner described in Section 6.8.3.

6.5.3.2.4 Revegetation of the Disposal Embankment

Reclamation will occur continuously. As the pile develops, about 30 to 40 acres will be covered with approximately 12 inches of topsoil each year. Each fall the topsoil deposited the previous year will be revegetated.

TABLE 6.5-1

Percent of Vegetative Cover Established On Retorted Oil Shale Test Plots

Site	Year and % Slope						
	1973	1974	1975	1976	1977		1978
	25%	25%	25%	25%	2%	25%	25%
Union Oil Co. site (1,770 m) seeded 1975:							
Unishale retorted shale	-	-	38	59	-	45	80
15 cm soil cover/Unishale B	-	-	73	56	-	37	87
30 cm soil cover/Unishale B	-	-	75	69	-	40	78
Soil Control	-	-	65	65	-	41	79
Union Oil Co. site (2,300 m) seeded 1975:							
Unishale retorted shale	-	-	-	42	-	18	36
15 cm soil cover/Union AGR	-	-	-	49	-	29	64
30 cm soil cover/Union AGR	-	-	-	51	-	29	71
Soil Control	-	-	-	65	-	41	79
Union Oil Co. site (2,300 m) seeded 1975:							
Unishale retorted shale	-	-	-	7	-	13	16
15 cm soil/Union AGR	-	-	-	47	-	46	33
Soil Control	-	-	-	76	-	54	69

Source: Environmental Perspective on the Emerging Oil Shale Industry, EPA-600/2-80-205a.

6.5 Land Disturbance and Reclamation

Seeding will be done with a Rangeland drill and a packer unit. The CB seed mix for the disposal pile will be used. Immediately following seeding, the area will be mulched. Mulch will be either straw "crimped in" at the rate of two tons per acre, or ground-up wood-fiber hydro-mulch applied at the rate of 1500 pounds per acre. Transplants will be planted in the spring following seeding and mulching.

Phosphate fertilizer (100 pounds of available phosphorus per acre) will be applied to the reclamation zone processed shale before topsoil is deposited. Nitrogen fertilizer (80 pounds of available nitrogen per acre) will be applied to the reseeded area the spring immediately following seeding. The need for additional fertilization will depend on soil sample analysis following the first growing season. If this analysis demonstrates the need for additional fertilization, it will be applied in the spring prior to the second growing season.

The revegetated areas will be sprinkle irrigated during the first growing season (and possibly the second) with a minimal amount of water. The amount of irrigation will be limited to the amount needed to establish revegetation during the first three years (8 inches of water the first year and only enough water in years 2 and 3 to supplement precipitation if it is below average).

6.5.4 Environmental Effects

During commercial operations about 450-500 acres will be occupied by the mine process and support facilities, and they will remain in a state of disturbance until abandonment. In any given year, the amount of land affected by the retorted shale pile minus the amount of land revegetated will be about 200 acres.

6.5 Land Disturbance and Reclamation

The main effect that land disturbances will have on the environment will be the temporary loss of habitat for wildlife and domestic livestock. This impact will be offset somewhat by mitigation measures used in nearby areas (see Section 6.11.3). In the long-run, all disturbed areas will be revegetated and there should be no residual impacts.

6.0 ENVIRONMENTAL EFFECTS AND CONTROL PLANS

6.6 Spills

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6.0 ENVIRONMENTAL EFFECTS AND CONTROL PLANS

6.6 Spills

This plan summarizes the potential sources of accidental spills; reviews the current regulations and standards that would apply to CB activities; defines and inventories the hazardous materials within the Plant; and summarizes CB spill prevention, control and contingency (SPCC) plans for the Plant and associated pipelines.

6.6.1 Potential Sources of Spills

During construction activities, spills of diesel fuels and other fuels and lubricants are possible during transportation, loading and unloading operations, both on-Tract and off-Tract at construction staging areas and rail spurs. Dust suppressants and smaller amounts of miscellaneous chemicals used during construction activities also pose pollution threats if quantities of these materials reach drainages or flowing streams near the Tract.

The on-Tract storage of approximately 245,000 barrels of shale oil poses the greatest potential spill volume. In the handling of large volumes of hydrocarbons, some small leaks or spills can be expected.

The pipelining of oil and byproducts is another potential source of spills, although pipelines are probably the safest method of transporting large volumes of gases and liquids. The trucking, loading, and unloading of hazardous supplies during plant operations as well as the trucking of ammonia and sulfur from the Plant will also be potential sources of accidental spills.

The types of hazardous materials that have been and will be stored on-Tract are identified in Table 6.6-1.

TABLE 6.6-1

Oil and Hazardous Materials Inventory

Material Stored On-Tract	Estimate of Commercial Operations Storage Capacity Bbl	1979 Storage Bbl	1980 Storage Bbl	1981 Storage Bbl	1982 Storage Bbl
Process Retort Water Stripper Feed	20,000	0	0	0	15
Process Condensate Water Stripper Feed	70,000	0	0	0	0
Plasticrete	100	50	50	90	1
Diesel Fuel	4,000	830	2,950	3,000	1,500
Gasoline	1,000	35	645	1,000	500
Motor Oil and Grease	70	0	0	70	50
Chlorine	50	10	10	0	0
Oil-Water Separator Liquid	1,000	0	0	0	0
LPG	1,000	190	850	837	595
Ammonia	2,200	0	0	0	0
Shale Oil	245,000	0	0	244	0
Sulfuric Acid	350	30	100	100	24
Caustic Soda	3,200	0	0	0	0
Phosphoric Acid	150	0	0	0	0
Oily Water	18,000	0	0	0	0
Foul Water	45,000	0	0	0	0
Sour Water	20,000	0	0	0	0
Off Spec Shale Oil	12,000	0	0	0	0
Oil/Water Emulsion	2,700	0	0	0	0

6.0 ENVIRONMENTAL EFFECTS AND CONTROL PLANS

6.6 Spills

6.6.2 Regulations and Permits

Section 7 of the Lease Stipulations requires that spill contingency plans for oil and other hazardous substances be submitted to OSPO and that these plans conform to the National Oil and Hazardous Substances Pollution Contingency Plan, 36 FR 16265, August 20, 1971, as amended. The national plan was developed by the Council on Environmental Quality in compliance with the Federal Water Pollution Control Act 33USC 1251. It has since been amended on September 9, 1972 (37 FR 184411) and December 21, 1972 (38 FR 2808).

Because the federal government has vested jurisdiction of Spill Prevention Control and Countermeasure (SPCC) plans in the U.S. Department of Transportation (U.S. Coast Guard, USCG) for transportation related facilities, and in the Environmental Protection Agency (EPA) for non-transportation related facilities, CB will prepare and will implement such SPCC plans at the time operations commence in accordance with the regulations of the USCG and EPA. These plans will be submitted to the OSPO after engineering design has been completed. In addition to spill plans, the Lease addresses (Lease Environmental Stipulations Section 2, E through H and Section 7, D) pipeline construction standards, pipeline safety standards, shut-off valves, pipeline corrosion, and storage and handling standards.

There are two classes of spill regulations: 1) oil, and 2) other hazardous substances. Regulations concerning oil spills have been extensively developed and modified. The EPA has published (38 FR 237-34164, December 11, 1973) regulations and guidelines requiring that owners of non-transportation related facilities, which could conceivably spill oil into the waters of the nation, prepare and implement an SPCC plan within six months after a facility first commences operation. The USCG has not yet made mandatory such a requirement for transporation related facilities.

6.6.3 Environmental Effects and Control Plan

There have been no reportable spills on the C-b Tract during the development of this site. Only minor oil and gasoline incidents have occurred within primary containment areas. Contaminated material was removed to the proper materials handling facility. No fines have been assessed and no notifications other than required annual reports to the OSPO have been made.

The SPCC plan provides the procedures that will be utilized if any spill, leak, discharge or release to navigable waters of oil or hazardous material occurs or the possibility exists.

There are four elements to the plan: prevention, detection, confinement and cleanup and disposal. The spill responsibilities described below identify general procedures while the following subsections identify facility specific prevention, detection, and confinement strategies.

6.6.3.1 Spill Response Management

Spill response management is implemented by a spill response team consisting of CB employees (Table 6.6-2). The spill response coordinator (SRC) manages the team and has management responsibility for spill response.

Any employee who sights an oil spill (or a spill of oily water) will immediately notify his supervisor and attempt to stop the source of the spill and its spread. The notified supervisor will immediately advise the SRC of the spill. The employee will convey to his supervisor or SRC as much information as possible:

Table 6.6-2

SPILL RESPONSE TEAM

SPILL RESPONSE TEAM	SRT MEMBER
Spill Response Coordinator (SRC)	D. Perdok
Cleanup Coordinator (CC)	S. L. Stringer
Government Liaison Coordinator (GLC)	E. B. Baker
Public Relations Coordinator (PRC)	R. E. Thomason
Legal Coordinator (LC)	D. R. Hale
Environmental Protection Coordinator (EPC)	E. B. Baker
Procurement and Logistics Coordinator (PLC)	T. L. Carruthers
Document Coordinator (CD)	T. H. Pysto
Accounting Coordinator (AC)	L. G. Barth
Training Coordinator (TC)	J. A. Fox
Safety and Security Coordinator (SSC)	E. L. Brake

6.6 Spills

1) Time of Incident
2) Location and direction of spill
3) Quantity of material spilled
4) Type of material spilled, including pertinent chemical data
5) Source of spill
6) Action taken
7) Current status of spill (source controlled, spill contained or flowing, assistance, etc.)

Upon identification of a spill, the SRC's first task is to implement containment and cleanup procedures. To facilitate this, the Cleanup Coordinator (CC) will identify from site drawings the unit which is the source of the spill and possible mitigation points (e.g., shut-off valves). The Environmental Protection Coordinator (EPC) must immediately determine if a spill is reportable and supervise the required reporting. Federal regulations call for immediate notification of a reportable spill. In practice, this means contacting the National and Regional Response Centers within a few hours or less after the spill occurs. As required, the EPC will contact the Legal and Public Relations departments for their assistance in the event of an oil spill.

All contacts with regulatory agencies and the press will be handled solely by the Public Relations Coordinator (PRC). The PRC will contact the Vice President of Regulatory Affairs; and he will report the spill to Cathedral Bluffs' management and the appropriate persons within the individual partnership companies.

Once the SRC is notified of a spill, he becomes responsible for proper cleanup of the spill and disposal of all waste material. At the completion of the cleanup, the Documentation Coordinator (DC) prepares a final report documenting the spill and the response. This report must include the following information:

1) Time, date and location of spill
2) Course and extent of spill
3) Condition of spill when reported
4) Mitigation measures applied
5) Disposal of wastes
6) Condition of site after mitigation is completed
7) Evaluation of response activity
8) Any recommendations to prevent repeat spills or to improve mitigation response.

6.6.3.2 Plant Site

6.6.3.2.1 Prevention

The first step in preventing spills is to analyze the potential which exists. Environmental assessment audits are carried out on a routine basis by corporate and site personnel. The objective of such an analysis is to identify facility weaknesses and to make engineering modifications which can significantly raise the level of spill prevention in the overall facility design. Statistics show that about 88% of all spills are the result of operator error, 10% are due to mechanical failure and 2% to all other causes. Thus, the area having the greatest possibility for improvement is increased operator reliability.

Operator reliability will be stressed while training new personnel who will be involved with transferring materials in the plant. Operating procedures for prevention of conditions and incidents leading to spills will be periodically reviewed. Another method of increasing operator reliability is through the use of additional warning and monitoring systems within the plant such as level alarms, back-flow indicators, etc.

6.6 Spills

The possibility of vandalism, such as the opening of valves, etc., is always present. Within the plant proper, with large numbers of employees present at all hours, the risks of vandalism should be relatively remote. At any outlying locations where unattended tanks or pipeline valves might be located, extra security precautions (fences, lights, regular patrols and locks) may be justified.

The overall design of the proposed oil shale processing complex will be unusually resistant to accidental spills which could have a significantly harmful effect on the environment. All large tanks will be diked to provide secondary protection in case of tank failure, accidental over-filling, etc. The dikes and all other liquid-containing systems will be designed to American Petroleum Institute standards as described in API Bulletin D16, First Edition, March 1974, and will be conventional structures of the type used in refineries. The methods and results of their use are widely known and accepted. In addition, all storm drainage from the plant, as well as the dikes, will be diverted to the approved erosion control basins. Thus a failure in the secondary dike containment system, which is designed for 110% of the stored volume, would result in a controlled spill into the erosion basins where treatment can also be applied. In that case, a dike failure in combination with a spill could result in a pollution threat. Such design situations will receive a thorough pre-construction analysis to minimize the level of risk and to provide additional mechanical safeguards and alarms where warranted.

6.6.3.2.2 Detection

The plant site will be continuously manned and visual observation will facilitate detection of leaks and spills.

6.6.3.2.3 Confinement

If at all possible, spills will be prevented from reaching the erosion basins. Neutralization, recovery, etc., are much more efficient if the material involved can be maintained in its original concentration. Therefore, the 110% storage design criterion is important for confinement (secondary containment structures around all tanks greater than 55 gallons).

For small spills of toxic or hazardous material, temporary containment techniques have been developed by EPA using foam-in-place plastic to build dams and barriers. Dispensing kits for the plastic foam will be located at convenient, well-marked locations throughout the plant. Also, absorbant material for cleanup will be available in the warehouse. Instructions in their use will be provided to employees on each shift.

6.6.3.2.4 Cleanup and Disposal

Since no in-plant spills are expected to breach either the diked boundaries or the erosion basins, cleanup will be relatively simple. In most cases, any spilled material will be pumped directly from the dike or other containment area directly back to the original source. If the material is contaminated to such an extent that it must be disposed of, it will likely be pumped first to a temporary holding tank and then removed by a commercial waste disposal firm. Similar plans will be prepared and implemented for other oil and hazardous substance storage areas.

6.6.3.3 Storm Water Runoff from Disturbed Areas

When sufficient rain water or runoff has collected in a containment or an erosion control basin, the surface of the water will be visually inspected for any film sheen or discoloration due to the presence of oil. If storm water is

contaminated with a hazardous material, the Environmental Protection Coordinator will determine action to be taken, i.e., separation of oil, neutralization, etc. Discharge from all erosion control structures must meet state discharge limitations per the NPDES permit.

6.6.3.4 Staging Area Spills

6.6.3.4.1 Prevention

Loading and unloading procedures will meet the minimum requirements and regulations established by the U. S. Department of Transportation. Warning signs will be prominently displayed and will identify the presence and loading of oil or hazardous material. Trucks will have brakes set, motors off, and wheels blocked where possible, and will not be moved at any time during the loading procedure. If any spill or leak occurs, all traffic in the area will be stopped immediately.

6.6.3.4.2 Detection

Driver, engineers, loaders and other personnel at the time of loading of any oil or hazardous material will be required to maintain constant surveillance for any sign of a spill or leakage of any material. Human observation shall be the basis of detection.

6.6.3.4.3 Confinement

Any potential spill of oil or other hazardous material in the staging area is expected to be very small in quantity. Small dikes or diversion facilities will be constructed in the staging area, and will hold the maximum capacity of any single compartment of a tank or truck in the area. In addition to foam-in-place containment techniques, the regular spill confinement equipment located at the plant will be used.

6.6.3.4.4 Cleanup and Disposal

Equipment and trained personnel located at the Plant site will also be available at all time for any spills in the staging area.

6.6.3.5 Trucking Spills

6.6.3.5.1 Prevention

During all loading operations, warning signs or other communication will be prominently displayed. Drivers will be required to set truck brakes, shut off motor, and exit the truck during loading. Trucks may not be moved until the loading operation is completed and the filling nozzle is removed from the truck and replaced in its rack. All drains and outlets from the trucks will be checked for leakage before, during, and after loading. If a spill or leak is detected, all truck traffic in the area will be stopped immediately.

6.6.3.5.2 Detection

Drivers, loaders, and other persons in the loading area will be required to be observant for signs of leakage or spillage. Detection will be assured through constant visual surveillance.

6.6.3.5.3 Confinement, Cleanup and Disposal

Except for any extraordinary accident, any oil spills from a truck will probably be very small and located exclusively on land. These small spills will be contained and cleaned up with the portable equipment stored at the Plant site. In addition, small man-made dikes or diversion ditches will be constructed in areas away from the plant to prevent the spread of a spill. Absorbents will also be utilized to contine and clean up spill. Disposal will be carried out by loading the oil or contaminated debris and absorbents into trucks for transporting back to the Plant disposal site.

6.6 Spills

No truck-related oil spills are expected to reach water sources. However, were this to happen, equipment and trained personnel from the Plant site would be immediately brought to the site to confine, cleanup and dispose of the oil, utilizing booms, barriers, separators and absorbents. Chemicals and dispersants will be used only as a last resort.

6.6.3.6 Byproducts

The SPCC Plan for byproducts such as ammonia and propane would be similar to that described above for the oil, with the major difference that the material will gasify when exposed to the ambient air, and will not spill out as a liquid. For this reason, the control measures to be undertaken for of a leak or spill will consist primarily of shutting off the valves nearest to the area, much as the control measures used with a natural gas pipeline. No confinement techniques will be needed, but notifying and evacuating people near problem area will have to be evaluated. Detection of leaks will be by visual observation and pressure monitors. Any leakage will be apparent from the frosting in the surrounding area.

Cleanup and disposal measures generally will not be needed due to the gaseous form of the material. The gas will escape to the atmosphere. This presents the additional threat of combustion of the gases while concentrated in the area. Special precautions will be taken to ensure that no flames are present following a leak, and the use of any motorized vehicles will be minimized. Following closing of the valves above the leak, the area will be restricted until the gases have dispersed.

6.6.3.7 Oil Pipeline

An SPCC Plan will be prepared for the product pipeline upon selection of the specific route and design of the pipeline.

The containment and countermeasure procedures established for the pipeline will emphasize (in areas other than where preconstructed diking systems are employed) bringing trained men and equipment to the scene as quickly as possible to analyze spills and initiate the established correction procedures. The route chosen for the pipeline will be such that containment and cleanup of any oil spill will most likely be on land. However, if the pipeline does cross a river, both land and water containment procedures will be required. Automatic shut-in at major stream crossings will be used.

Although each potential oil spill location requires individual consideration of techniques to be employed, the general methods described below are applicable to the overall system and route.

On-site source control will be critical. It involves closing manual valves and immediate repair, permanent or temporary, of the damaged or malfunctioning equipment. Some sites may warrant more rapid shut-in by automatic or remote valve drives.

Varying physical conditions will require a wide variety of methods and equipment to control spreading oil. In addition, the time lag for the arrival of men and equipment will affect the type of control methods to be used. Surveillance and good communication procedures will be critical to the effective control of the spreading of oil.

6.6 Spills

The general technique used to control the spread of oil involves constructing dikes or diversion ditches, employing booms or barriers (when the oil spill has reached water), using absorbents (such as straw and commercial products, usable on both land and water) and using chemicals (restricted by regulation) to disperse or coalesce the oil on water. If the release of oil is necessary to make repairs on the system, temporary, lined ponds or mobile containers will be utilized to hold any oil released.

The plan will contain extensive cleanup and removal procedures. The basic components of these procedures include collection and recovery of oil and contaminated debris, removal of soil and vegetation, and cleanup of the affected area. Contaminated debris, soil and vegetation will be removed by a commercial solid waste disposal company.

6.6.4 Environmental Effects

Over the life of the Project it is probable that some spill events will occur. The possible nature and effects of events are problematic.